Nemko Korea Co., Ltd.

165-51, Yurim-ro, Cheoin-gu, Yongin-si, Gyeonggi-do,17042, Republic of Korea
TEL:+82 31 330-1700 FAX:+82 31 322 2332

FCC & IC EVALUATION REPORT FOR CERTIFICATION

Project No. : NK-24-R-410
Applicant : SOLUM CO., LTD.
4, 5, 6th F, 357, Guseong-ro, Giheung-gu, Yongin-si, Gyeonggi-do, South Korea

Dates of receipt : September 26, 2024
Dates of Issue : March 16, 2025
Test Site :
Nemko Korea Co., Ltd.

FCC ID :	**2AFWNWT10FACNDW0HSM**
IC :	**22800-WT10FACND**
Applicant :	**SOLUM CO., LTD.**
Brand Name :	**SOLUM**
Model:	**WT10FACNDW0HSM**
Additional Model(s):	**WT10FACNDU0HSM** **WT10FACNDW1HSM, WT10FACNDU1HSM** **WT10FACNDW2HSM, WT10FACNDU2HSM** **WT10FACNDW3HSM, WT10FACNDU3HSM**
EUT Type:	**Information Technology Audio Video**
Classification:	**FCC Part 15 Spread Spectrum Transmitter (DSS)**
Date of Test:	**October 24, 2024 ~ December 27, 2024**
Applied Standard:	**FCC 47 CFR Part 15.247** **RSS-Gen Issue 5, RSS-247 Issue 3**

The device bearing the brand name and model specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. The client should not use it to claim product endorsement by TAF or any government agencies. The test results in the report only apply to the tested sample.

I attest to the accuracy of data and all measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested By : Yonghwan Kim
Test Engineer

Reviewed By : Hoonpyo Lee
Technical Manager

Revision History

Rev.	Issue Date	Revisions	Revised By
00	March 16, 2025	Initial issue	Yonghwan Kim

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Test facility

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2014), the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013) was used in determining radiated and conducted emissions emanating.

These measurement tests were conducted at **Nemko Korea Co., Ltd.**
The site address 165-51, Yurim-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17042, Rep. of Korea.

2.2 Accreditation and listing

Accreditation type		Accreditation number
FC	CAB Accreditation for DOC	Designation No. KR0026
KOLAS	KOLAS Accredited Lab. (Korea Laboratory Accreditation Scheme)	Registration No. KT155
Industry Canada	Canada IC Registered site	Site No. 29506
VCCI	VCCI registration site(RE/CE/Telecom CE)	Member No. 2118
IECEE CB SCHEME	EMC CBTL	TL124
KC	KCC(RRL)Designated Lab.	Registration No. KR0026

2. EUT INFORMATION & TEST CONDITIONS

2.1 EUT Information

2.1.1 Specifications:

EUT Type	Information Technology Audio Video
Model Name	WT10FACNDW0HSM
Frequency of Operation	2 402 MHz ~ 2 480 MHz
Peak Output Power (Conducted)	9.75 dBm
Number of Channels	79 CH
Modulations	GFSK, π/4DQPSK, 8DPSK
Antenna Gain (peak)	1.12 dBi
Antenna Setup	1TX / 1RX
EUT Rated Voltage	DC 9 V ~ 24 V
EUT Test Voltage	DC 12 V
HVIN (Hardware Version Number)	WT10FACNDW0HSM
FVIN (Firmware Version Identification Number)	V1.1
Remarks	-

2.2 Operation During Test

The EUT is the transceiver which is Bluetooth v5.0 supporting Bluetooth BR/EDR mode.
The Laptop PC was used to control the EUT to transmit the wanted TX channel continuously (duty cycle < 98%) by the testing program (CMD) and testing command supported by manufacturer.
The operating voltage of EUT was 12 Vdc supplied from AC/DC Adapter.

The EUT was tested at the lowest, middle and the highest channels with the maximum output power in accordance with the manufacturer's specifications. The worst data were recorded in the report.

2.2.1 Table of Test power setting

Frequency	Mode	Modulation	Power setting Level
2 402 MHz ~ 2 480 MHz	BDR	GFSK	default
	EDR	π/4DQPSK	default
	EDR	8DPSK	default

2.2.2 Table of Test frequency

Frequency band	Modulation	Test Channel (CH)	Frequency (MHz)
2.4 GHz	GFSK, π/4DQPSK, 8DPSK	0	2 402
		39	2 441
		78	2 480

2.2.3 Antenna Information

Frequency band	Modulation	Antenna TX mode	Support CDD	Support MIMO
2.4 GHz	GFSK, π/4DQPSK, 8DPSK	■ 1TX, □ 2TX	□ Yes, ■ No	□ Yes, ■ No

2.2.4 Additional Information Related to Testing

The cable and attenuator loss from 30 MHz to 26.5 GHz was reflected in spectrum analyzer with correction factor for all conducted testing.

2.2.5 Worst-case Configuration and Mode

Radiated emission below 1GHz was performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Radiated emission above 1GHz was performed with the EUT set to transmit low/mid/high channels.

The emissions (Band-edge & spurious emissions) were investigated in three orthogonal orientations X, Y and Z.
Accordingly, the orientation was determined and tested as shown in the table below:

Test Items	X	Y	Z
Band-edge	O	-	-
Spurious emissions	O	-	-

2.2.6 Additional model covered by this report

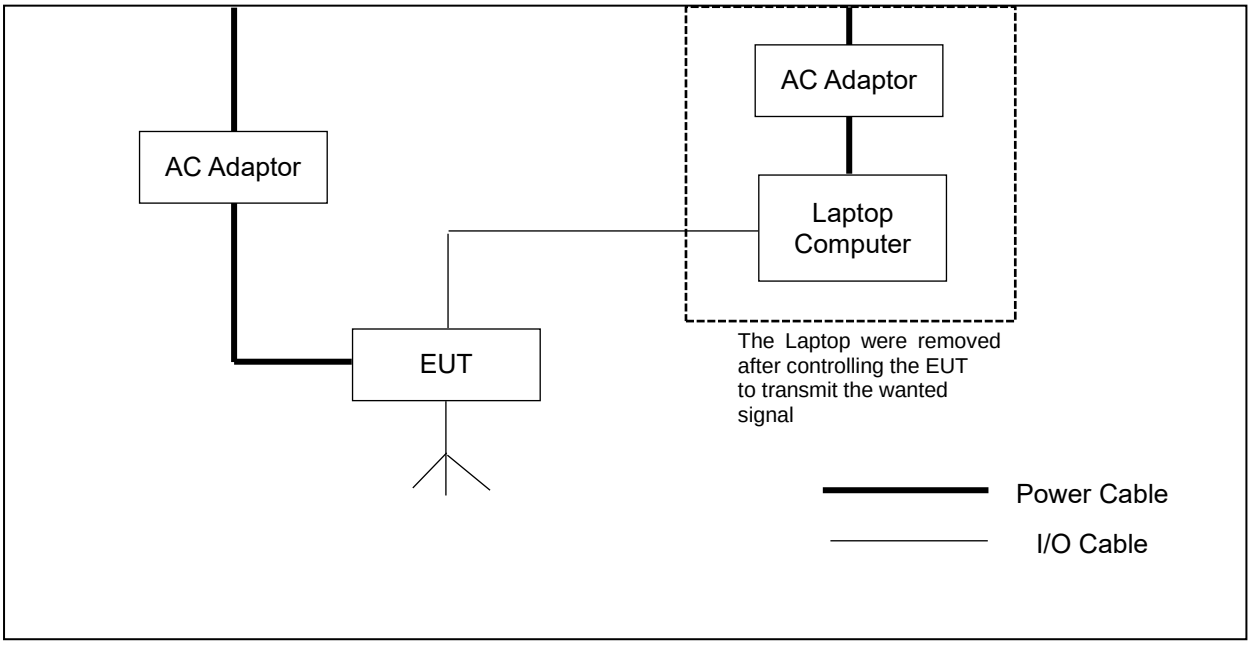
- The variant models shell use electric circuits that are the same as the basic model.
- The difference between basic and variant models are as below table.

Basic model name		Description	
WT10FACNDW0HSM		Dual display	
Variant model name	Description	Variant model name	Description
WT10FACNDU0HSM	- Dual display - Purpose for marketing	WT10FACNDW1HSM	- Single display - Purpose for marketing
WT10FACNDW2HSM		WT10FACNDU1HSM	
WT10FACNDU2HSM		WT10FACNDW3HSM	
-	-	WT10FACNDU3HSM	

2.3 Support Equipment

EUT	SOLUM CO., LTD. Model : WT10FACNDW0HSM	S/N: N/A
Laptop Computer	HP Model : G62-355TU	FCC DOC S/N : CNF0489WDT
AC Adapter	HP123 Model : PPP009D	FCC DOC S/N : WBGSV0ACXZH162

2.4 Setup Drawing



3. ANTENNA REQUIREMENTS

Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission under FCC part 15 and RSS-Gen.

§15.203 of the FCC Rules part 15 Subpart C

: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

RSS-Gen Section 6.8

: The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below)

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.
Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

The transmitter has permanently attached FPC antenna (Internal antenna) inside the EUT case.

Used Antenna	
Model name	2 400 MHz ~ 2 500 MHz
	Max. peak gain (dBi)
WT10FACNDW0HSM	1.12

4. SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specification:

Name of Test	FCC Paragraph No.	IC Paragraph No.	Test Limit	Test Condition	Result	Remark
20 dB Bandwidth	15.247(a)(1)	RSS-247(5.1)(b)	-	Conducted	Complies	-
Peak Output Power	15.247(b)(1)	RSS-247(5.4)(b)	< 125 mW		Complies	-
Carrier Frequency Separation	15.247(a)(1)	RSS-247(5.1)(b)	> two-thirds of the 20 dB bandwidth		Complies	-
Number of Hopping Channel	15.247(a)(1)(iii)	RSS-247(5.1)(d)	More than 15 channels		Complies	-
Transmitter Average Time of Occupancy	15.247(a)(1)(iii)	RSS-247(5.1)(d)	< 0.4 s		Complies	-
Band Edge / Conducted Spurious Emission	15.247(d)	RSS-247(5.5)	≥ 20 dBc		Complies	-
Radiated Spurious Emission	15.205, 15.209	RSS-Gen (8.9) (8.10)	< 74 dBµV/m (PK) < 54 dBµV/m (AV) Radiated limits detailed in 15.209	Radiated	Complies	-
AC Line Conducted Emission	15.207	RSS-Gen(8.8)	FCC 15.207 Limits	Line Conducted	Complies	-

5. TEST METHODOLOGY

1. FCC CFR 47 Part 2.
2. FCC CFR 47 Part 15.
3. KDB 558074 D01 15.247 Meas Guidance v05r02.
4. RSS-Gen Issue 5.
5. RSS-247 Issue 3.
6. ANSI C63.10-2013.

6. DESCRIPTION OF TESTS

6.1 Duty Cycle

Test Setup

Test Measurement Method

ANSI C63.10-2013, Section 11.6

Test Procedure

EUTs Duty Cycle is measured at low channel with a spectrum analyzer connected to the antenna terminal while the EUTs operating at its maximum power control level.
The spectrum analyzer setting is as follows.

RBW ≥ OBW

VBW ≥ RBW
Span = zero span
Detector = Peak
The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100.

6.2 20 dB Bandwidth

Test Setup

Test Measurement Method

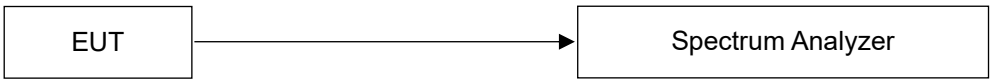
ANSI C63.10-2013, Section 6.9.2
RSS-Gen section 6.7

Test Procedure

The transmitter is set to the Low, Middle, High channels is connected to the spectrum analyzer.
Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel
RBW = 1% to 5% of the OBW
VBW = approximately 3 x RBW
Detector = Peak
Trace mode = max hold
Sweep = auto
Allow trace to fully stabilize.
The bandwidth measurement function on the spectrum analyzer is used to measure the 20 dB bandwidth.

6.3 Carrier Frequency Separation

Test Setup



Test Measurement Method

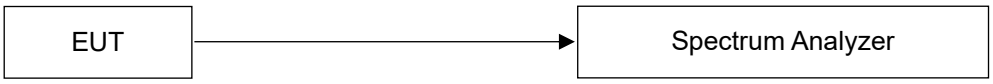
ANSI C63.10-2013, Section 7.8.2

Test Procedure

The EUT must have its hopping function enabled. The following spectrum analyzer setting is used.
Span = wide enough to capture the peaks of two adjacent channels
RBW ≥ approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel
VBW ≥ RBW
Sweep = auto
Detector = peak
Trace = max hold
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

6.4 Transmitter Average Time of Occupancy

Test Setup



Test Measurement Method

ANSI C63.10-2013, Section 7.8.4

Test Procedure

The transmitter output is connected to a spectrum analyzer. The following spectrum analyzer setting is used.
Span = Zero span, centered on a hopping channel
RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector = Peak
Trace = Single sweep
Use the marker-delta function to determine the width of pulse

6.5 Number of Hopping Channels

Test Setup

Test Measurement Method

ANSI C63.10-2013, Section 7.8.3

Test Procedure

Span = The frequency band of operation.
RBW = less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
VBW ≥ RBW
Sweep = Auto
Detector = Peak
Trace = Max hold
Allow trace to fully stabilize.

6.6 Peak Output Power

Test Setup

Test Measurement Method

ANSI C63.10-2013, Section 7.8.5

Test Procedure

The transmitter is set to the Low, Middle, High channels is connected to the spectrum analyzer.
Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
RBW > 20 dB bandwidth of the emission being measured
VBW ≥ RBW
Sweep = auto
Detector = peak
Trace = max hold

6.7 Conducted Spurious Emissions

Test Setup

Test Measurement Method

ANSI C63.10-2013, Section 7.8.6, 7.8.8

Test Procedure

Measurements are made over the 30 MHz to 26.5 GHz range with the transmitter set to the Lowest, middle and highest channels.
RBW = 100kHz
VBW = 300kHz
Sweep = auto
Detector = peak
Trace = max hold

6.8 Radiated Emissions

Test Measurement Method

ANSI C63.10-2013, Section 6.6.4.3, Section 11.11, Section 11.12

Test Procedure

The measurement was performed at the test site that is specified in accordance with ANSI C63.10-2013. The spurious emission was scanned from 9 kHz to 30 MHz using Loop Antenna and 30 to 1000 MHz using Trilog broadband test antenna. Above 1 GHz, Horn antenna was used.
For emissions testing at below 1GHz, The test equipment was placed on turntable with 0.8 m above ground. For emission measurements above 1 GHz, The test equipment was placed on turntable with 1.5 m above ground. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The EUT, cable, wire arrangement and mode of operation that has the highest amplitude relative to the limit was selected. Then, the turn table was rotated from 0˚ to 360˚ and an antenna mast was moved from 1 m to 4 m height to maximize the suspected highest amplitude signal. The final maximized level was recorded.

At frequencies below 1000 MHz, measurements performed using the CISPR quasi-peak detection. At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in ANSI 63.10-2013 section 11.12. Peak emission levels were measured by setting the analyzer RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Trace mode = max hold. Average emission levels were measured by setting the analyzer RBW = 1 MHz, VBW = 1 kHz, Detector = Peak, Trace mode = max hold. Allow max hold to run for at least 50 times (1/duty cycle) traces.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100	3
88–216	150	3
216–960	200	3
Above 960	500	3

Radiated Emissions Limits per 47 CFR 15.209(a) & RSS-Gen (8.9)

6.9 AC Line Conducted Emissions

Test Measurement Method

ANSI C63.10-2013, Section 6.2

Test Procedure

The Line conducted emission test facility is located inside a 4 x 7 x 2.5 meter shielded enclosure.

It is manufactured by EM engineering. The shielding effectiveness of the shielded room is in accordance with MIL-STD-285 or NSA 65-6. A 1 m x 1.5 m wooden table 0.8 m height is placed 0.4 m away from the vertical wall and 1.5 m away from the side of wall of the shielded room. Rohde & Schwarz (ENV216) of the 50 ohm/50 μH Line Impedance Stabilization Network (LISN) are bonded to the shielded room. The EUT is powered from the Rohde & Schwarz LISN. Power to the LISNs are filtered by high-current high insertion loss Power line filters. The purpose of filter is to attenuate ambient signal interference and this filter is also bonded to shielded enclosure. All electrical cables are shielded by tinned copper zipper tubing with inner diameter of 1 / 2 ”. If DC power device, power will be derived from the source power supply it normally will be powered from and this supply lines will be connected to the LISNs, All interconnecting cables more than 1 meter were shortened by non-inductive bundling (serpentine fashion) to a 1 meter length. Sufficient time for EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer to determine the frequency producing the maximum EME from the EUT. The spectrum was scanned from 150 kHz to 30 MHz with 200 msec sweep time. The frequency producing the maximum level was re-examined using the EMI test receiver. (Rohde & Schwarz ESR3). The detector functions were set to CISPR quasi-peak mode & average mode. The bandwidth of receiver was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each EME emission. Each emission was maximized by; switching power lines; varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and of support equipment, and powering the monitor from the floor mounted outlet box and computer aux AC outlet, if applicable; whichever determined the worst case emission.

Each EME reported was calibrated using the R&S signal generator.

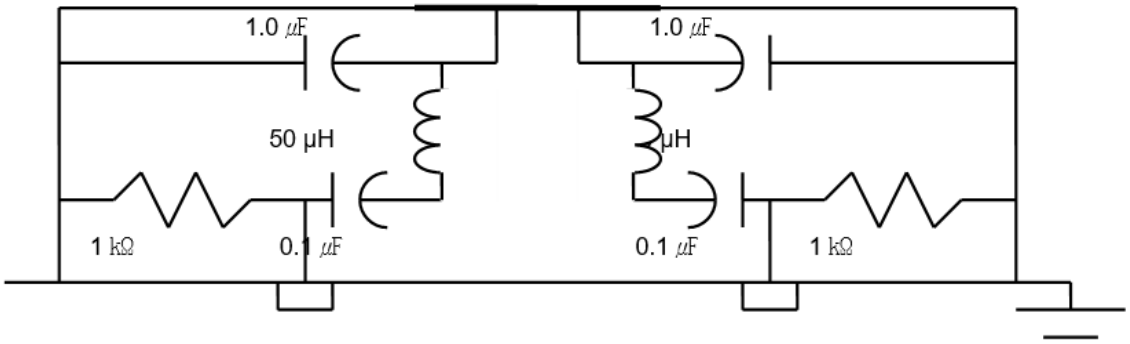


Fig. 2. LISN Schematic Diagram

7. TEST DATA

7.1 Duty Cycle

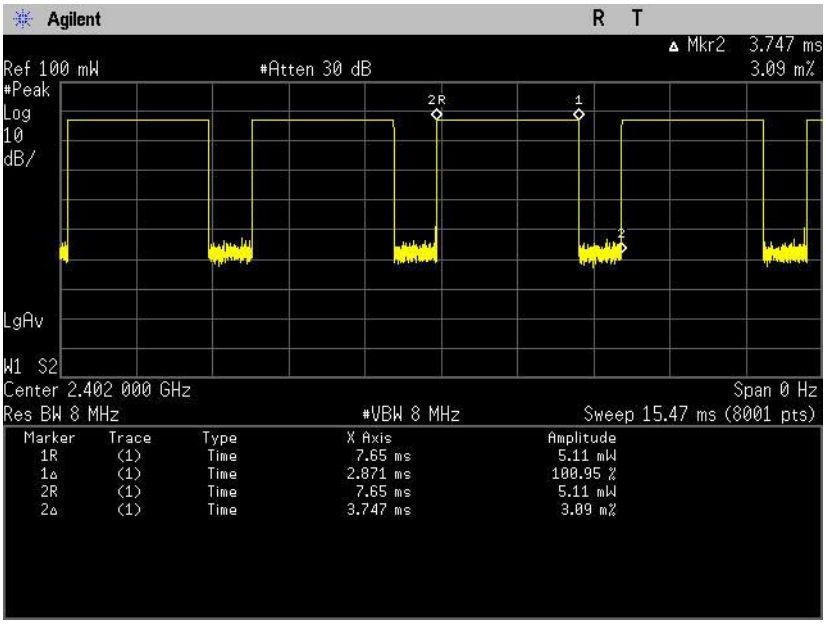
For reporting purposes only.

Result

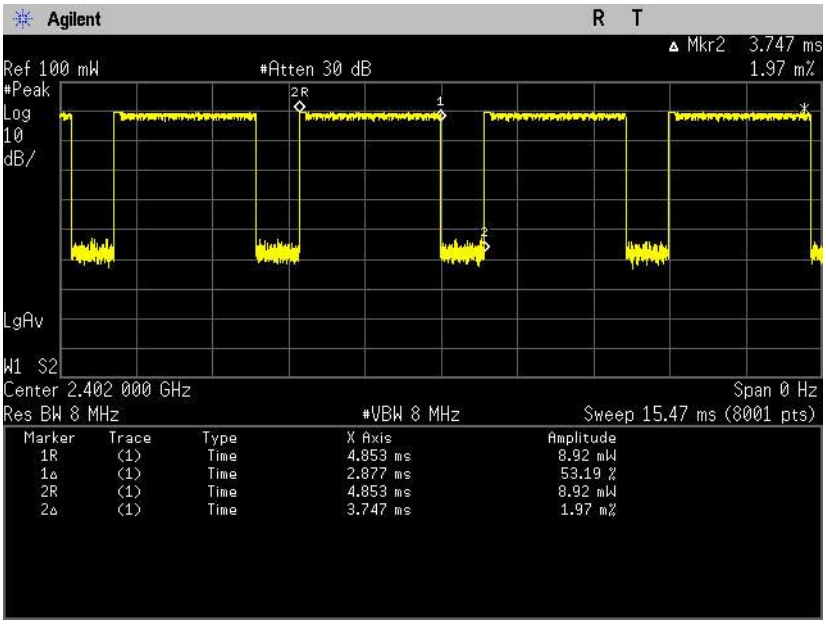
Mode	On time [msec]	Period [msec]	Duty cycle x [Linear]	Duty Cycle [%]	Duty Cycle Correction Factor [dB]	1/T Minimum CBW [kHz]
GFSK	2.871	3.747	0.766	76.62	1.16	0.35
π/4DQPSK	2.877	3.747	0.768	76.78	1.15	0.35
8DPSK	2.879	3.747	0.768	76.83	1.14	0.35

PLOTS OF EMISSIONS

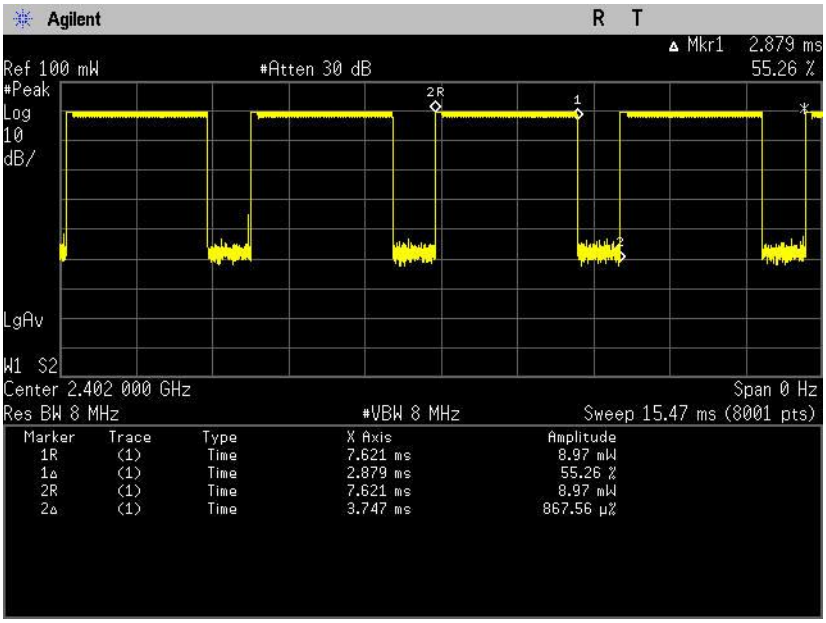
Duty Cycle, GFSK, Lowest Channel (2 402 MHz)



Duty Cycle, π/4DQPSK, Lowest Channel (2 402 MHz)



Duty Cycle, 8DPSK, Lowest Channel (2 402 MHz)



7.2 20 dB Bandwidth

FCC §15.247(a)(2)
RSS-247(5.1)(b), RSS-Gen (6.7)

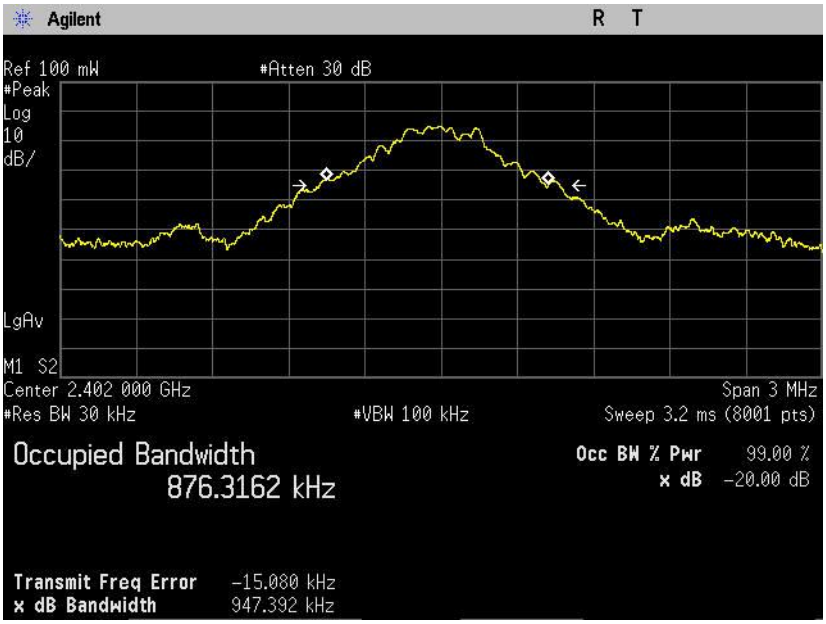
Test Mode : Set to Lowest channel, Middle channel and Highest channel

Result

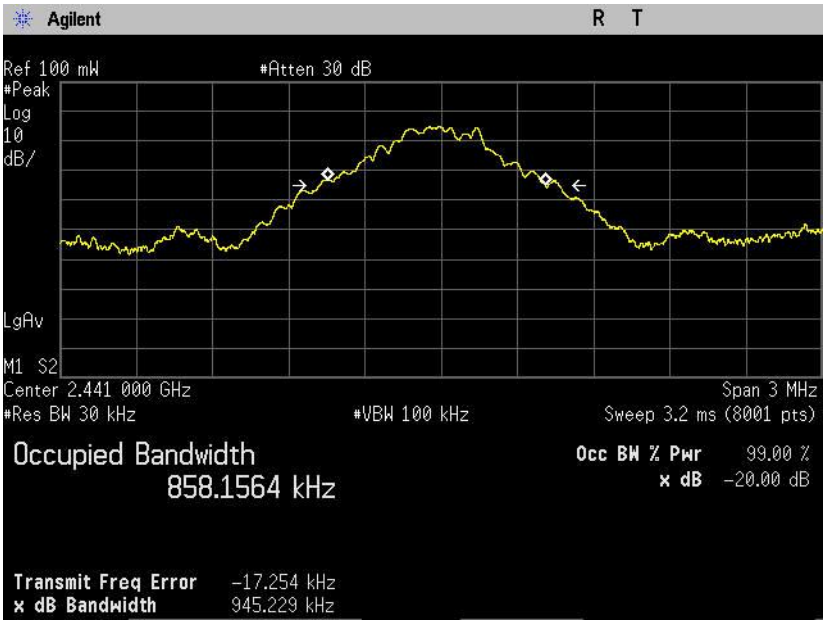
Modulation	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
GFSK	Lowest	2 402	0.95
	Middle	2 441	0.95
	Highest	2 480	0.95
π/4DQPSK	Lowest	2 402	1.27
	Middle	2 441	1.27
	Highest	2 480	1.27
8DPSK	Lowest	2 402	1.28
	Middle	2 441	1.28
	Highest	2 480	1.29

PLOTS OF EMISSIONS

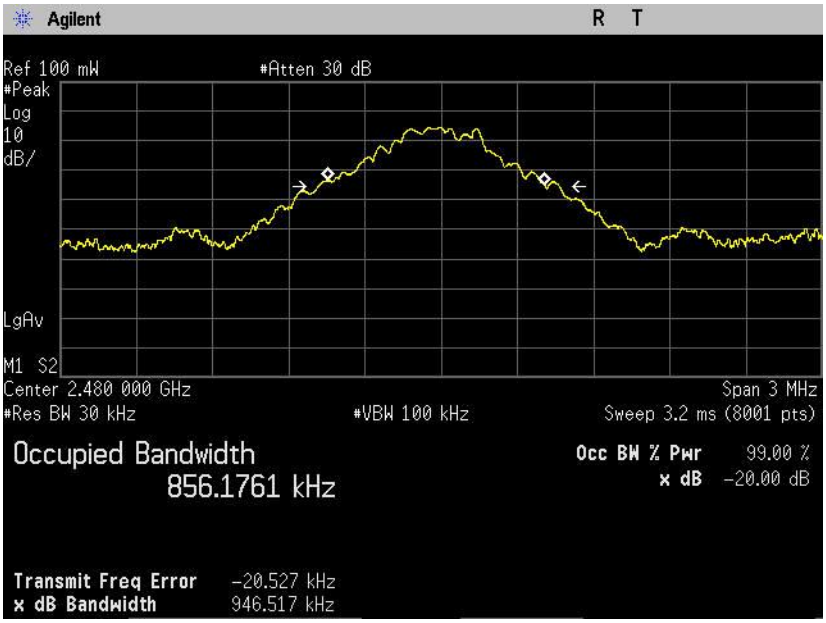
GFSK, 20 dB Bandwidth, Lowest Channel (2 402 MHz)



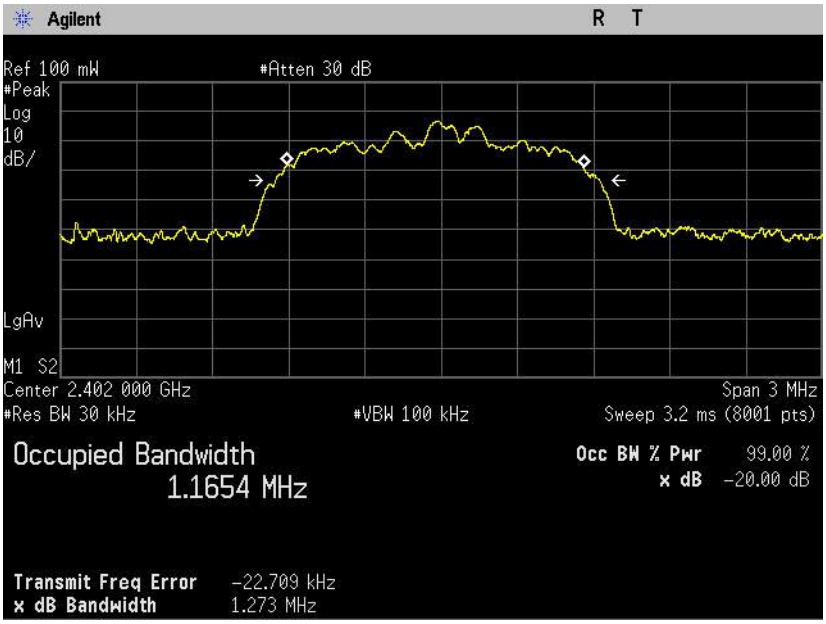
GFSK, 20 dB Bandwidth, Middle Channel (2 441 MHz)



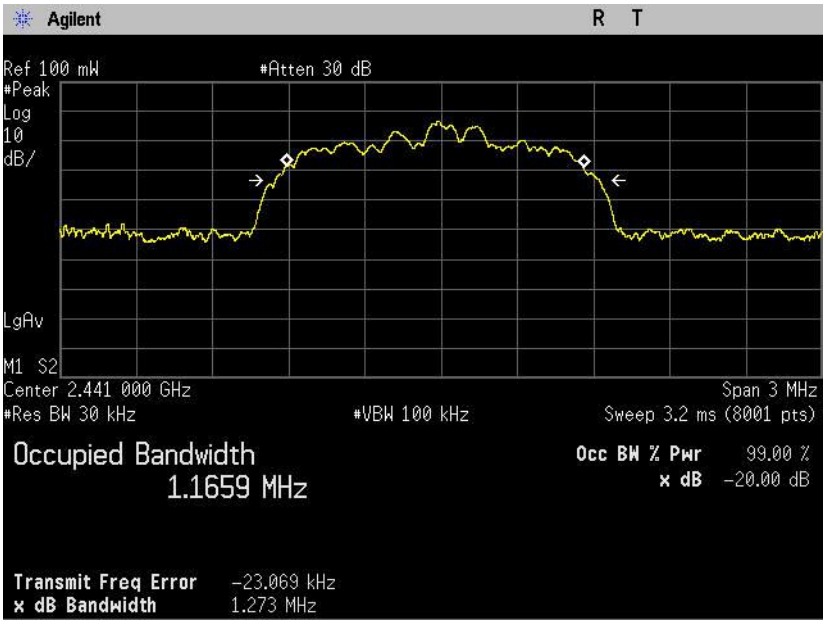
GFSK, 20 dB Bandwidth, Highest Channel (2 480 MHz)



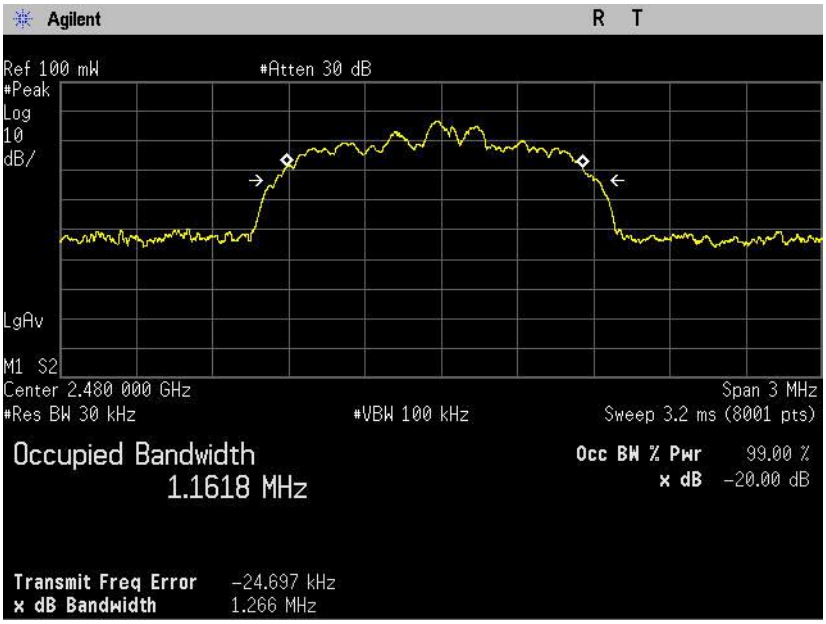
π/4DQPSK, 20 dB Bandwidth, Lowest Channel (2 402 MHz)



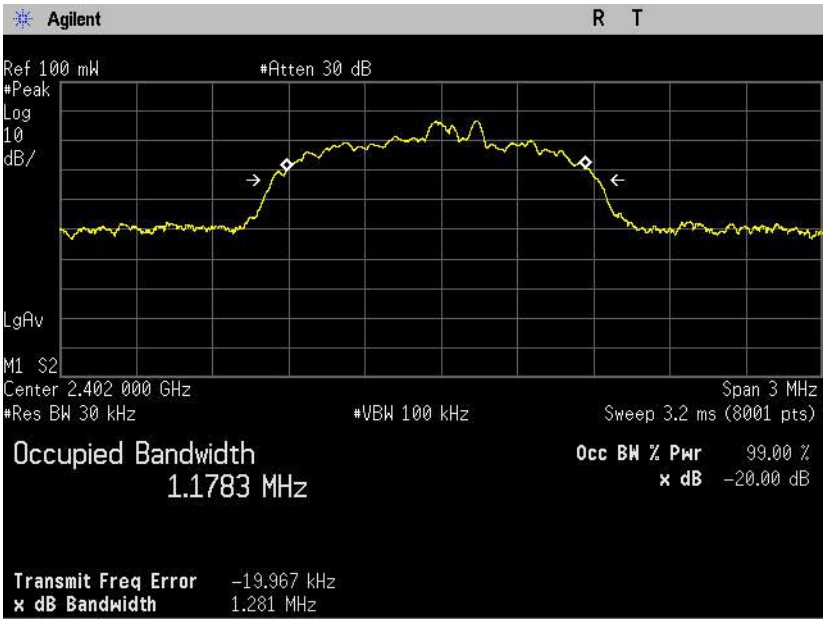
π/4DQPSK, 20 dB Bandwidth, Middle Channel (2 441 MHz)



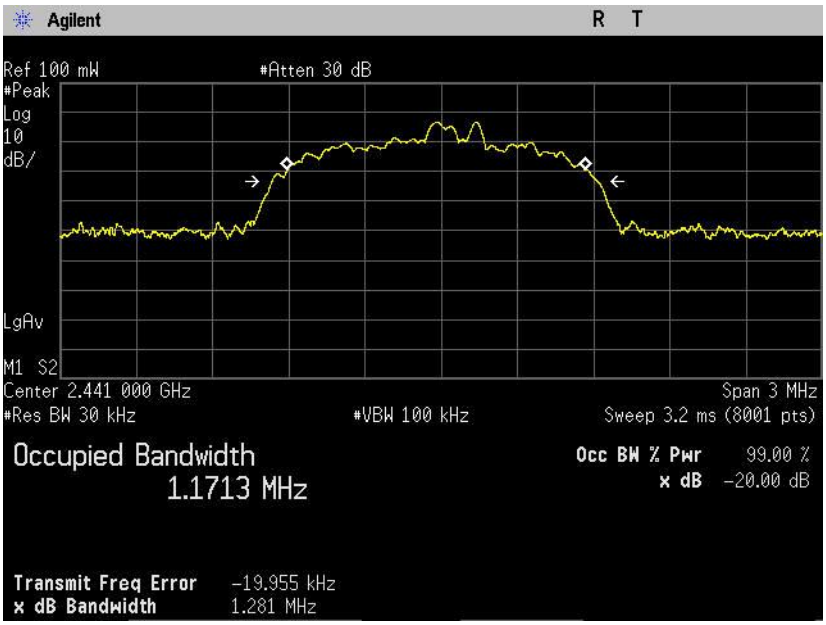
π/4DQPSK, 20 dB Bandwidth, Highest Channel (2 480 MHz)



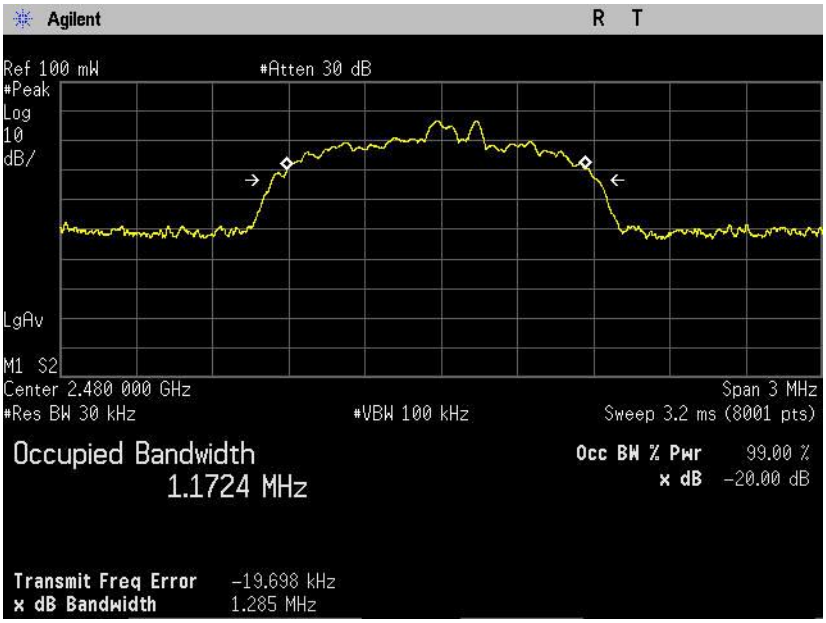
8DPSK, 20 dB Bandwidth, Lowest Channel (2 402 MHz)



8DPSK, 20 dB Bandwidth, Middle Channel (2 441 MHz)



8DPSK, 20 dB Bandwidth, Highest Channel (2 480 MHz)



7.3 Carrier Frequency Separation

FCC §15.247(a)(1)
RSS-247(5.1)(b)

Test Mode : Set to Hopping mode

Result

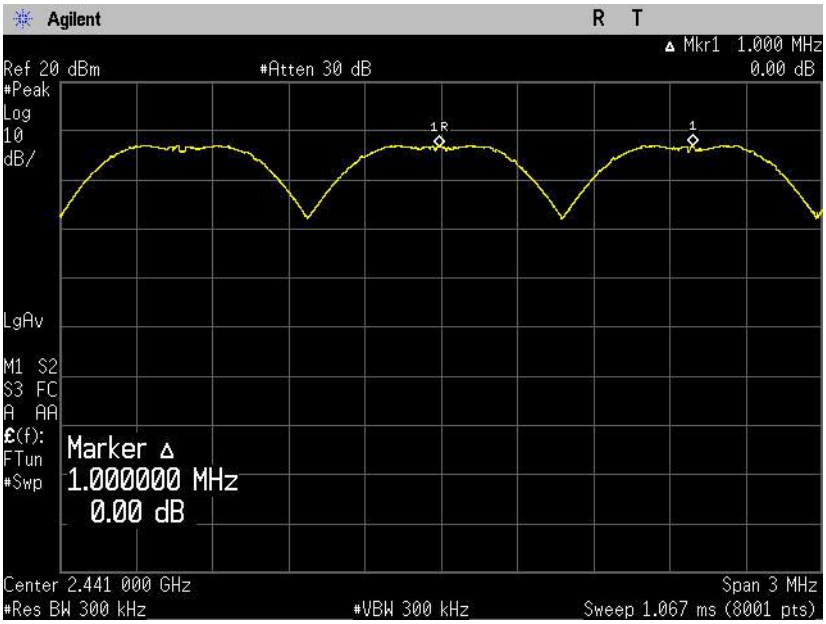
Modulation	Carrier Frequency Separation (MHz)	Limit (2/3 of 20dB Bandwidth) (MHz)
GFSK	1.00	0.63
π/4DQPSK	1.00	0.85
8DPSK	1.00	0.86

Note:

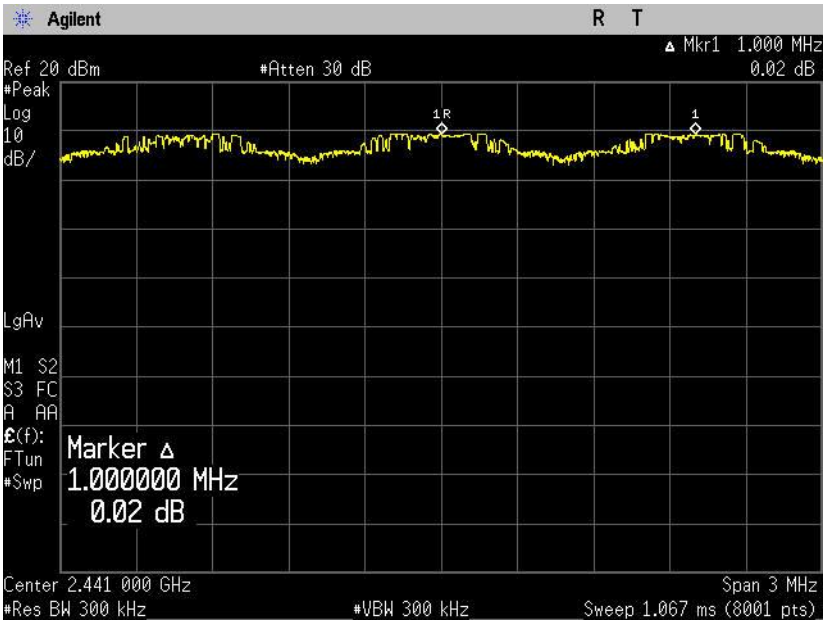
*The EUT complies with the minimum channel separation requirement when it is operating **1x/EDR mode using 79 channels** and when operating in **AFH mode using 20 channels**.*

PLOTS OF EMISSIONS

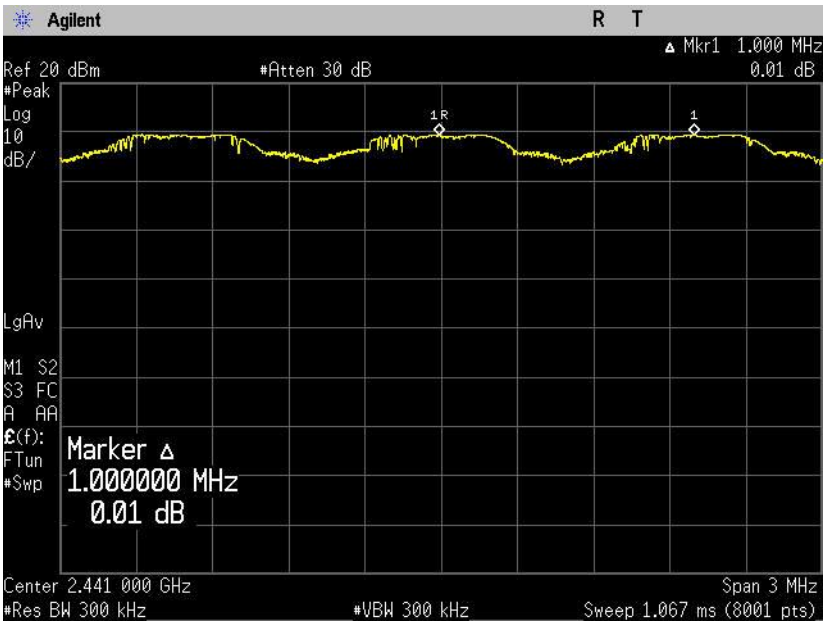
Carrier Frequency Separation, GFSK modulation



Carrier Frequency Separation, π/4DQPSK modulation



Carrier Frequency Separation, 8DPSK modulation



7.4 Transmitter Average Time of Occupancy

FCC §15.247(a)(1)
RSS-247(5.1)(d)

Test Mode : Set to Hopping mode

Result

Mode	Pulse width (ms)	*)Numbers of slots	**) Average time of Occupancy (ms)	Limit (ms)	Margin (ms)
1x/EDR	2.87	106.67	306.24	400	93.76
AFH	2.87	53.33	153.12	400	246.88

1x/EDR mode

1) This result was measured at DH5 mode in **1x/EDR mode**, which has longest time in one transmission burst.

2) Bluetooth 1x/EDR mode has a channel hopping rate of 1 600 hops/s and 79 hopping channels.

3) The average time of occupancy in the specified 31.6 second period (79 channels x 0.4 s) is equal to pulse width x (hopping rate / 6) / 79 x (0.4 x hopping channels).

4) *) Numbers of slots in 31.6 sec = (1 600 / 6) / 79 x 31.6 = 106.67

5) **) Average time of Occupancy = Pulse width x 106.67

AFH mode

1) This result was measured at DH5 mode in **AFH mode**, which has longest time in one transmission burst.

2) Bluetooth AFH mode has a channel hopping rate of 800 hops/s and 20 hopping channels.

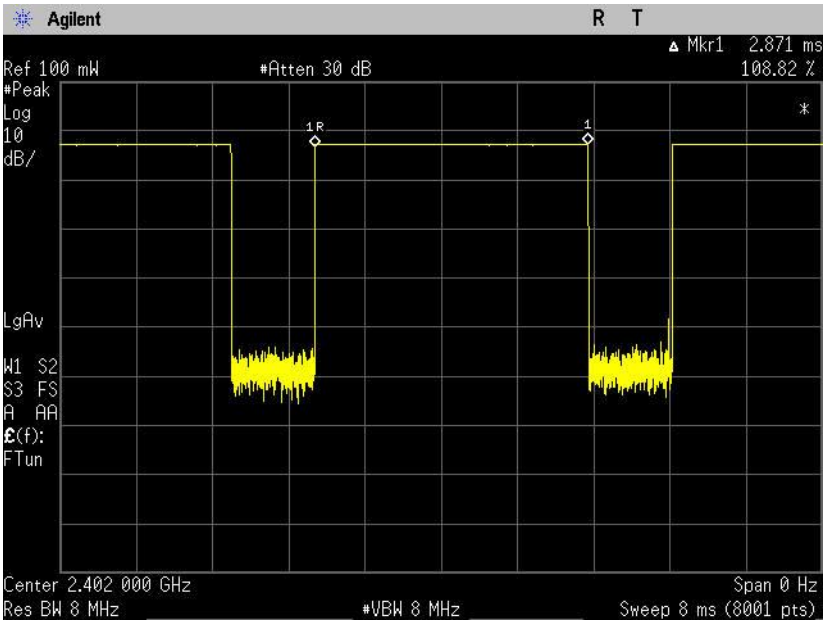
3) The average time of occupancy in the specified 8 second period (20 channels x 0.4 s) is equal to pulse width x (hopping rate / 6) / 20 x (0.4 x hopping channels).

4) *) Numbers of slots in 20 sec = (800 / 6) / 20 x 8 = 53.33

5) **) Average time of Occupancy = Pulse width x 53.33.

PLOTS OF EMISSIONS

Pules width, DH5



7.5 Number of Hopping Channels

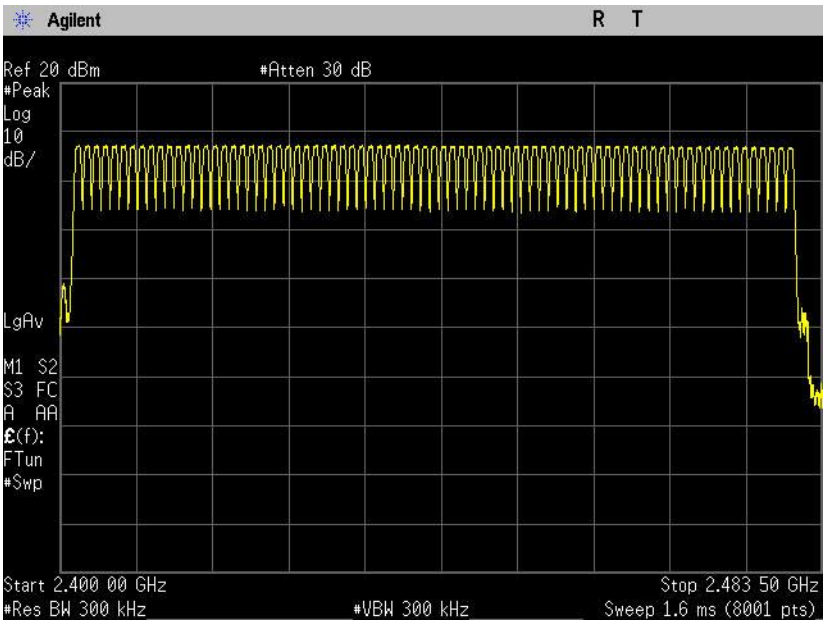
FCC §15.247(a)(1)(iii)
RSS-247(5.1)(d)

Test Mode : Set to Hopping mode

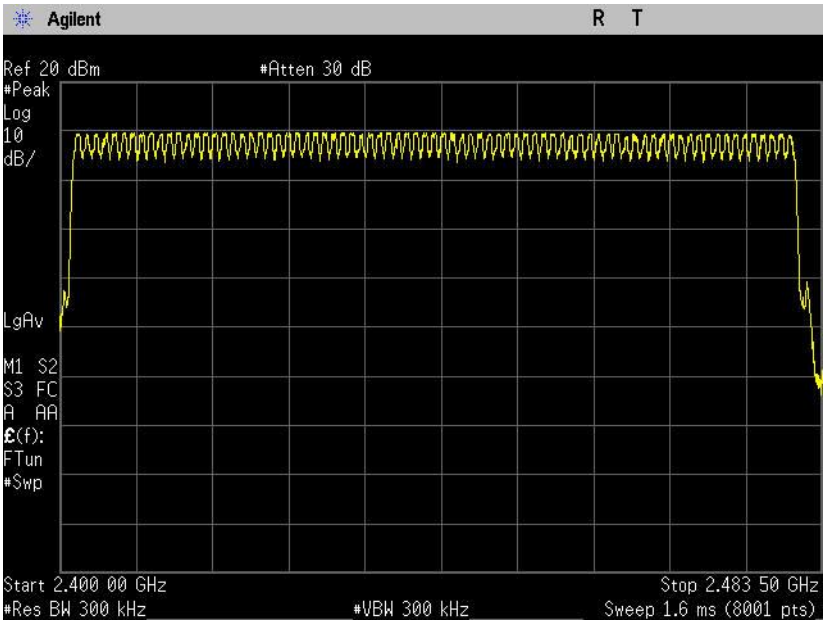
Result

The EUT complies with the minimum of 15 hopping channels when it is operating 1x/EDR mode using 79 channels and when operating in AFH mode using 20 channels

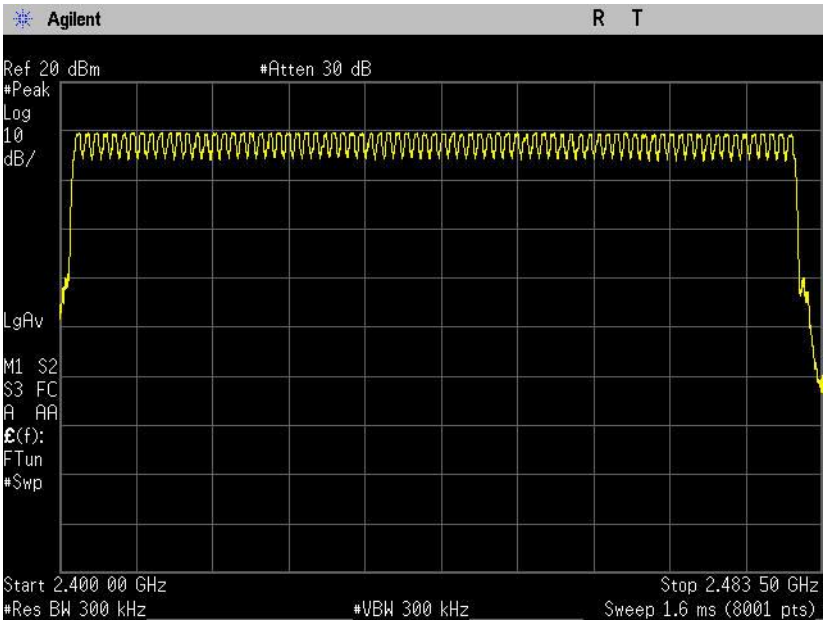
Number of hopping channels, GFSK



Number of hopping channels, π/4DQPSK



Number of hopping channels, 8DPSK



7.6 Peak Output Power

FCC §15.247(b)(3)
RSS-247(5.4)(b)

Test Mode : Set to Lowest channel, Middle channel and Highest channel

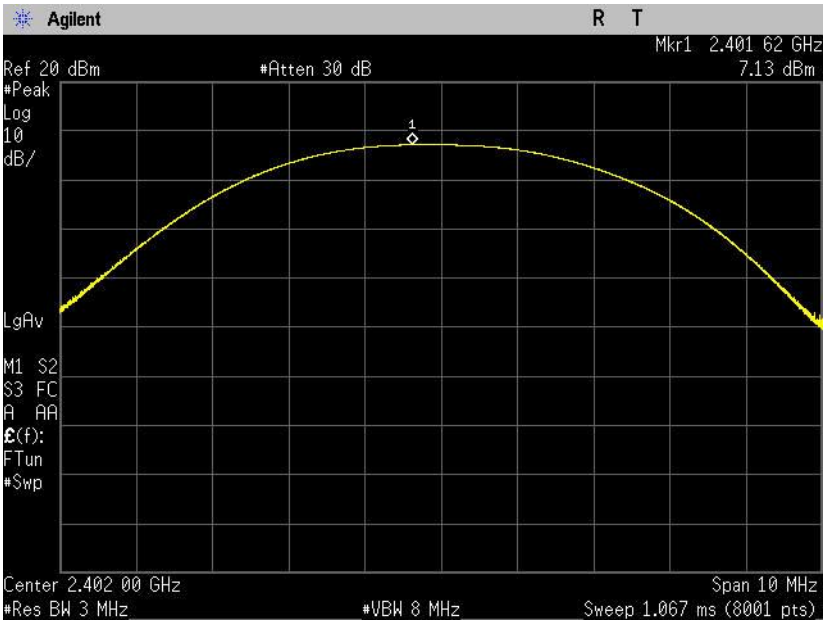
Result

Modulation	Channel	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)	E.I.R.P (dBm)	E.I.R.P Limit (dBm)
GFSK	Lowest	2 402	7.13	20.97	8.25	36.00
	Middle	2 441	7.09	20.97	8.21	36.00
	Highest	2 480	6.83	20.97	7.95	36.00
π/4DQPSK	Lowest	2 402	9.48	20.97	10.60	36.00
	Middle	2 441	9.48	20.97	10.60	36.00
	Highest	2 480	9.27	20.97	10.39	36.00
8DPSK	Lowest	2 402	9.75	20.97	10.87	36.00
	Middle	2 441	9.73	20.97	10.85	36.00
	Highest	2 480	9.46	20.97	10.58	36.00

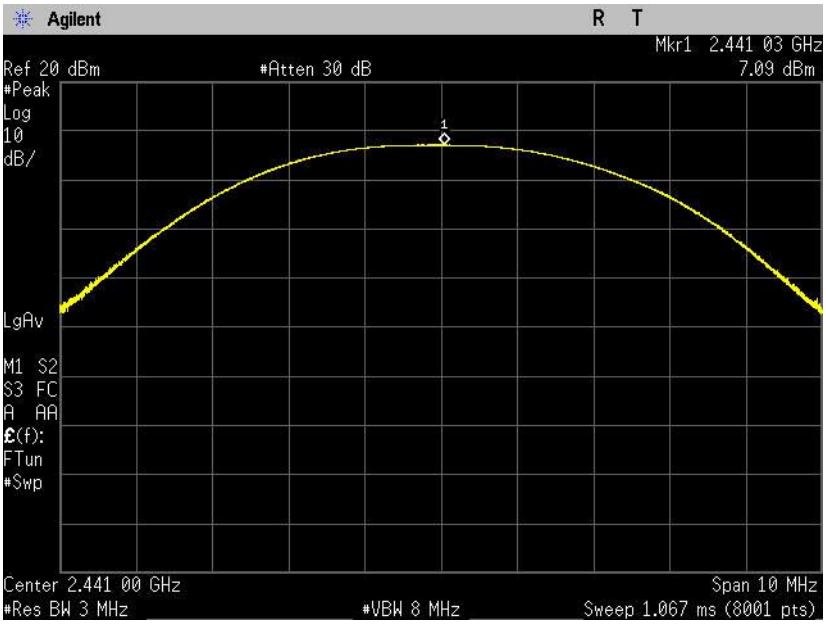
Notes:
1. The following equation was used for spectrum offset:
Spectrum offset (dB) = Attenuator (dB) + Cable Loss (dB) + SMA Type Connector Loss (dB)

PLOTS OF EMISSIONS

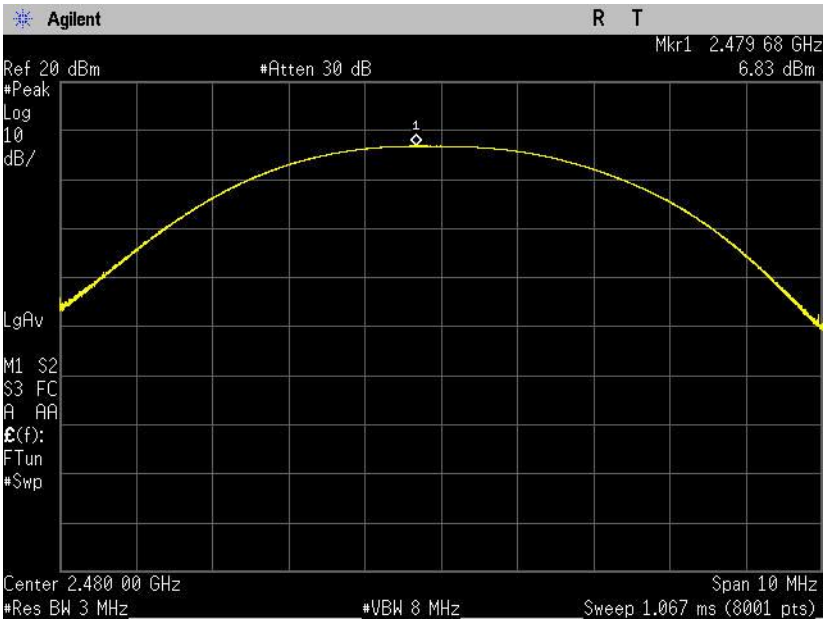
Maximum Peak Output Power, GFSK, Lowest Channel



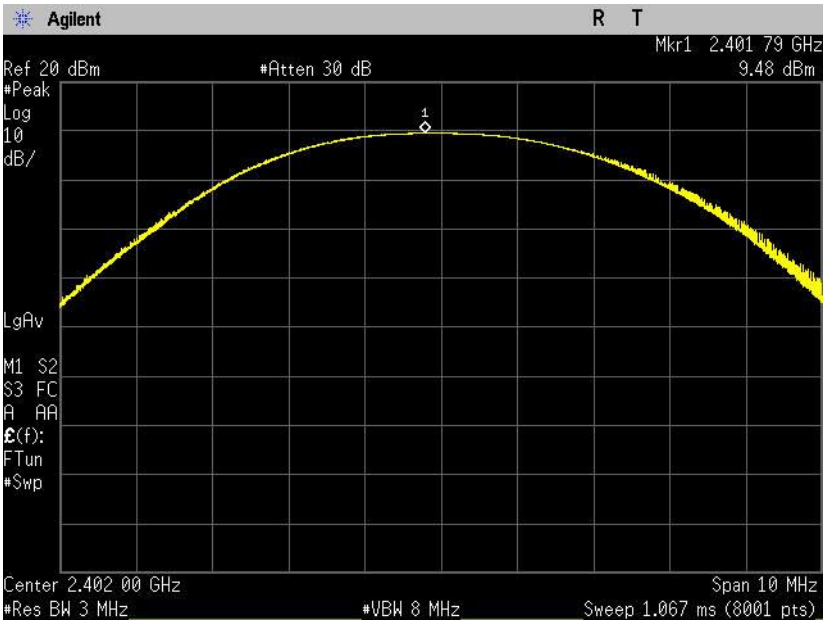
Maximum Peak Output Power, GFSK, Middle Channel



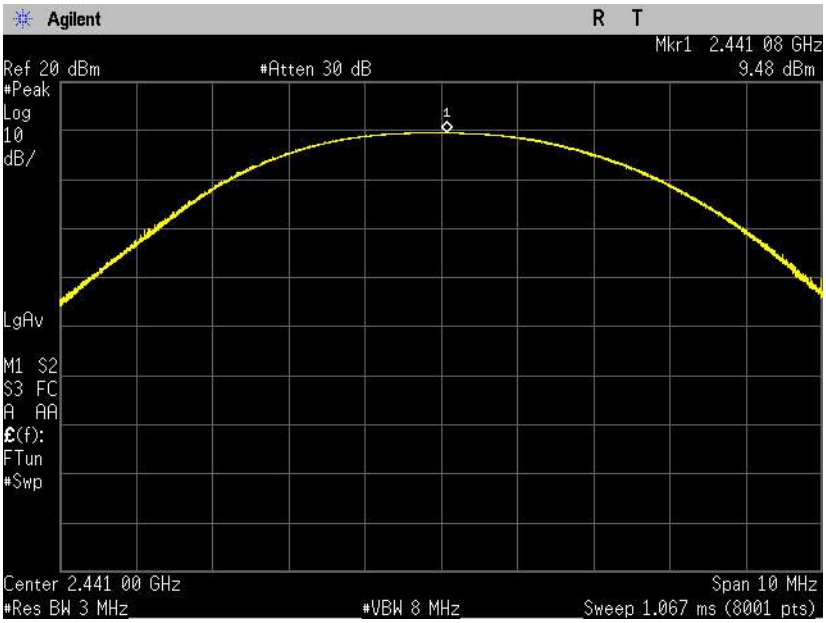
Maximum Peak Output Power, GFSK, Highest Channel



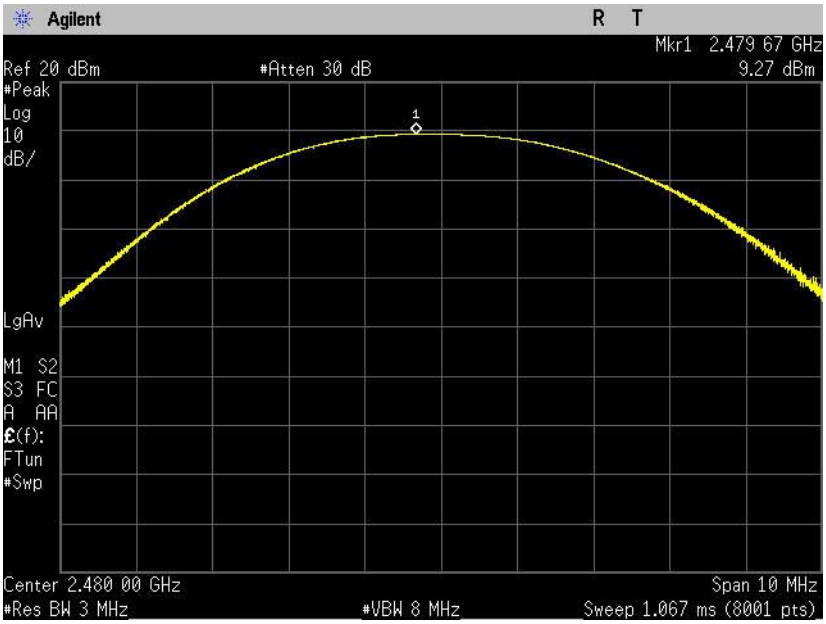
Maximum Peak Output Power, π/4DQPSK, Lowest Channel



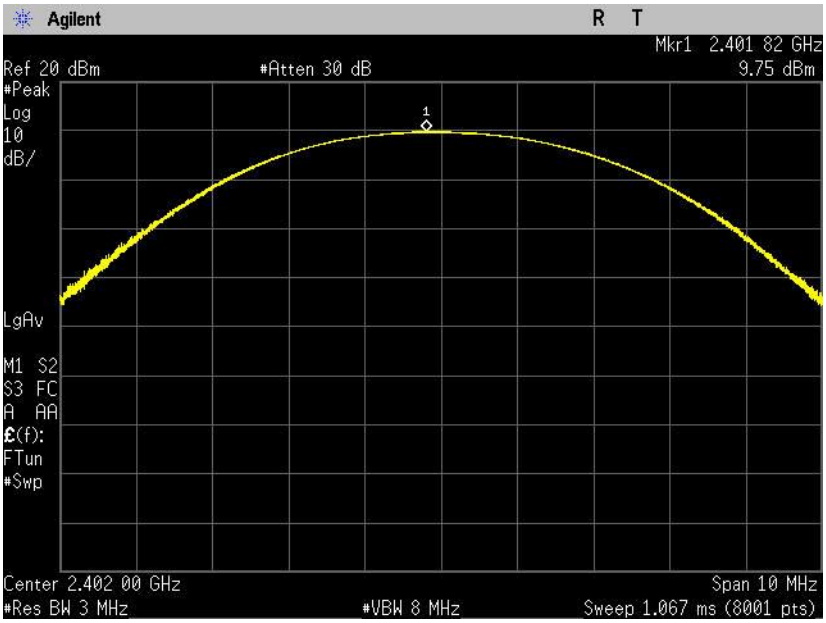
Maximum Peak Output Power, π/4DQPSK, Middle Channel



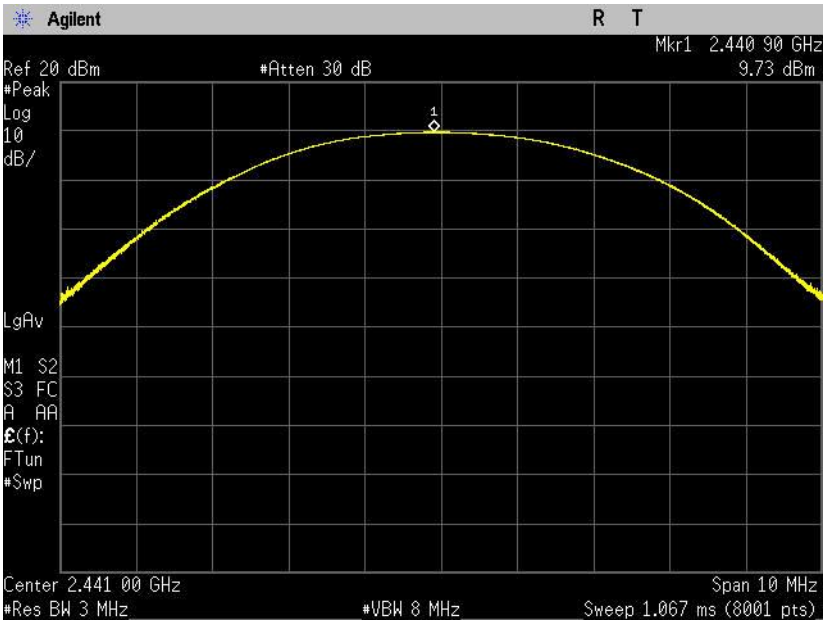
Maximum Peak Output Power, π/4DQPSK, Highest Channel



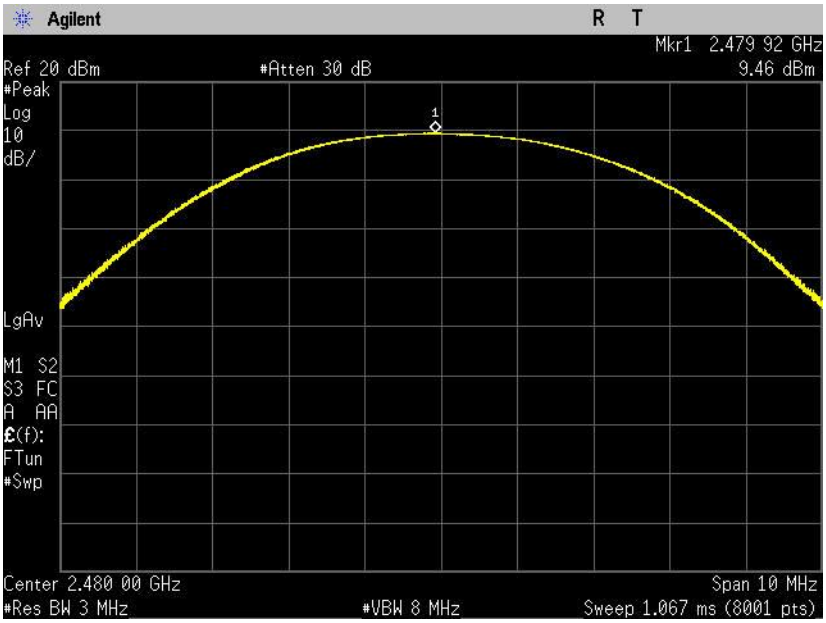
Maximum Peak Output Power, 8DPSK, Lowest Channel



Maximum Peak Output Power, 8DPSK, Middle Channel



Maximum Peak Output Power, 8DPSK, Highest Channel



7.7 Conducted Spurious Emissions

FCC §15.247(d)
RSS-247(5.5)

Test Mode : Set to Lowest channel, Middle channel and Highest channel

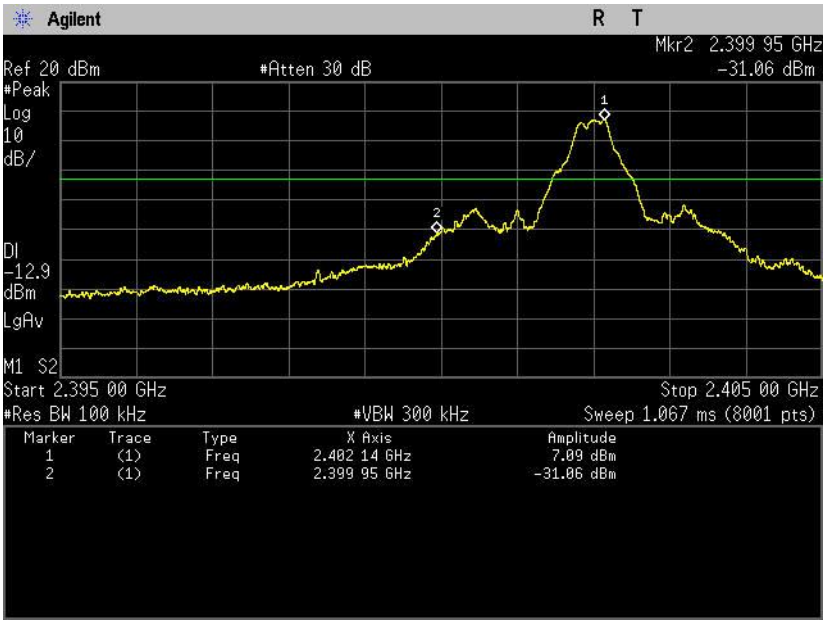
Result

Modulation	Channel	Frequency (MHz)	Conducted Spurious Emissions (dBc)	Limit (dBc)
GFSK	Lowest	2 402	More than 20 dBc	20
	Middle	2 441	More than 20 dBc	20
	Highest	2 480	More than 20 dBc	20
π/4DQPSK	Lowest	2 402	More than 20 dBc	20
	Middle	2 441	More than 20 dBc	20
	Highest	2 480	More than 20 dBc	20
8DPSK	Lowest	2 402	More than 20 dBc	20
	Middle	2 441	More than 20 dBc	20
	Highest	2 480	More than 20 dBc	20

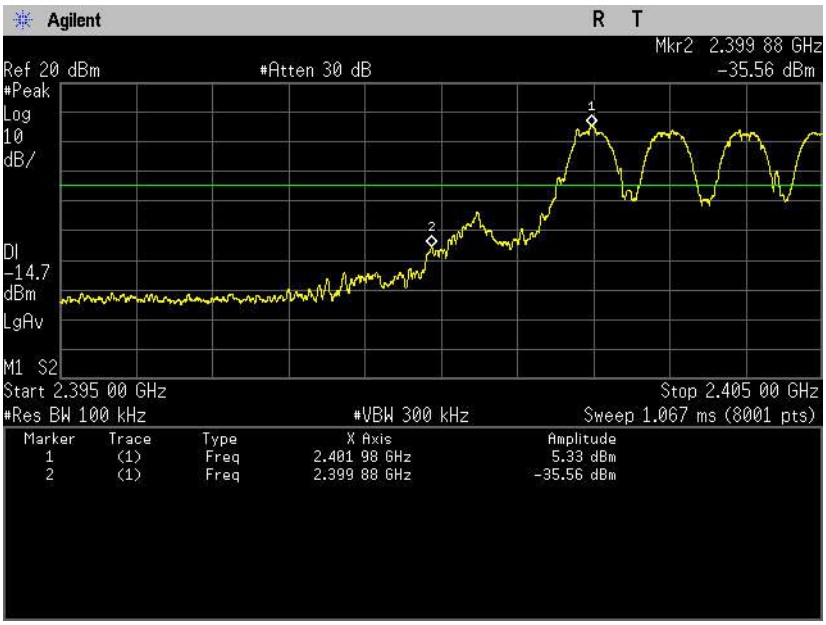
Notes:
The cable and attenuator loss from 30 MHz to 26.5 GHz was reflected in spectrum analyzer with correction factor for the spurious emissions test.

PLOTS OF EMISSIONS

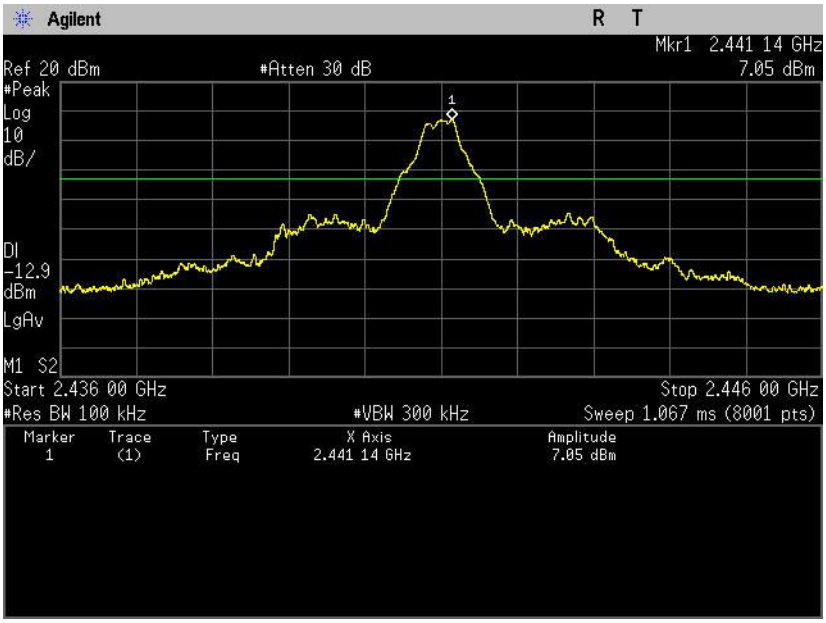
Band Edge, GFSK, Lowest Channel (2 402 MHz)



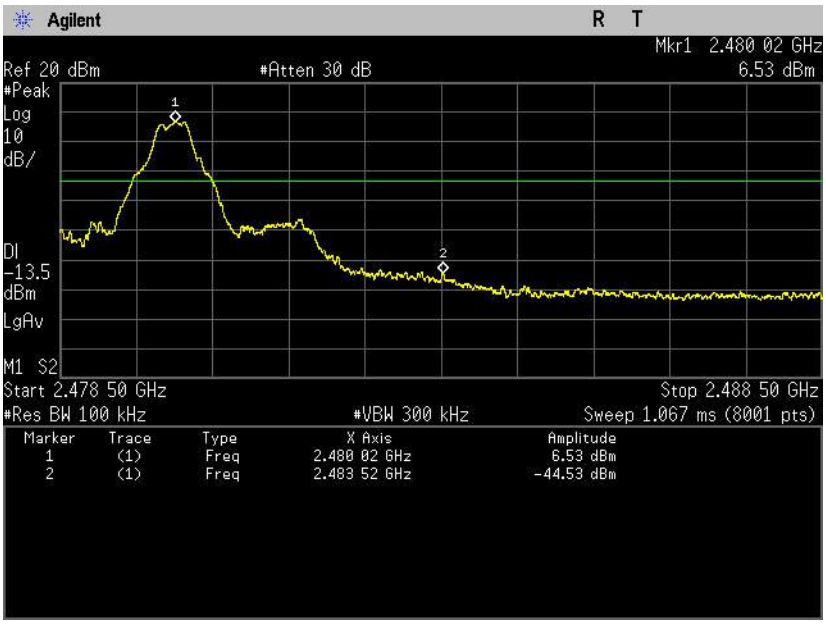
Band Edge, Hopping mode, GFSK, Lowest Channel (2 402 MHz)



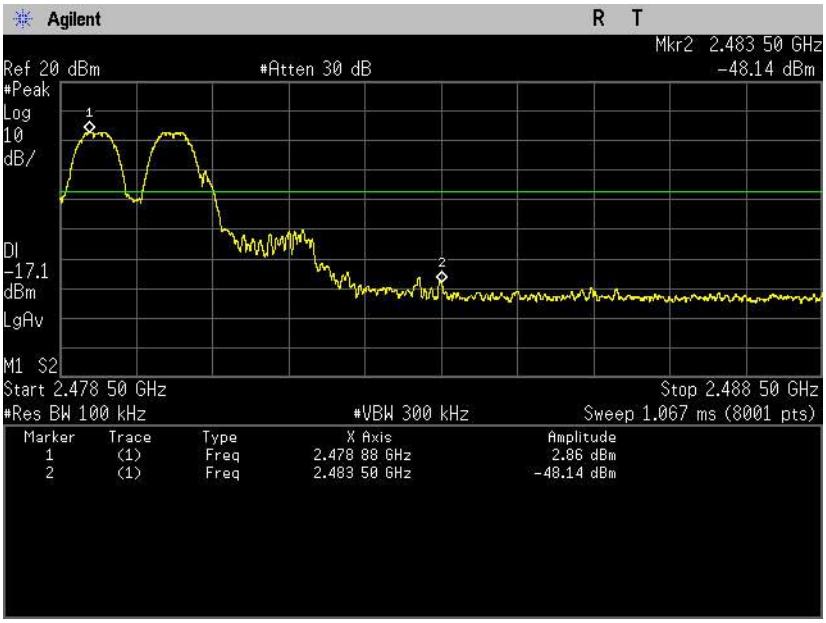
Reference Level, GFSK, Middle Channel (2 441 MHz)



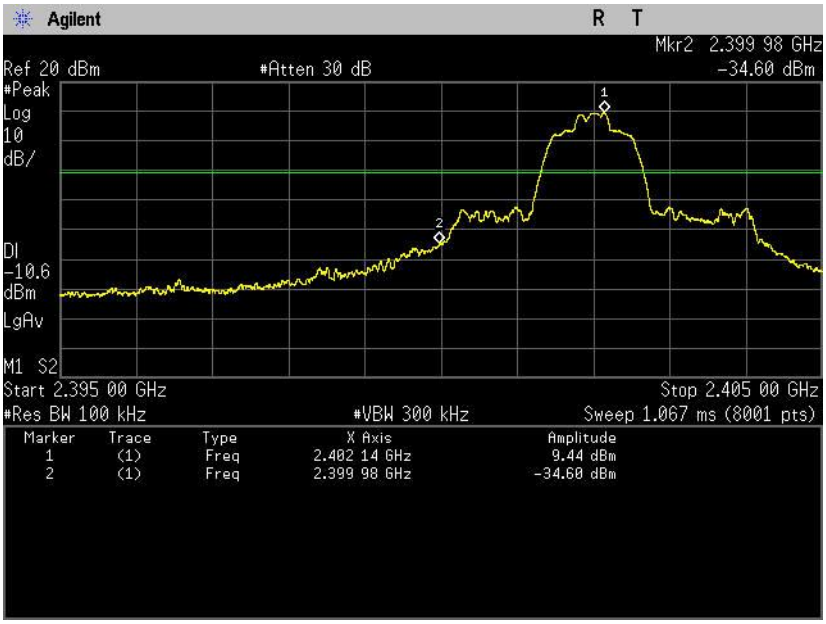
Band Edge, GFSK, Highest Channel (2 480 MHz)



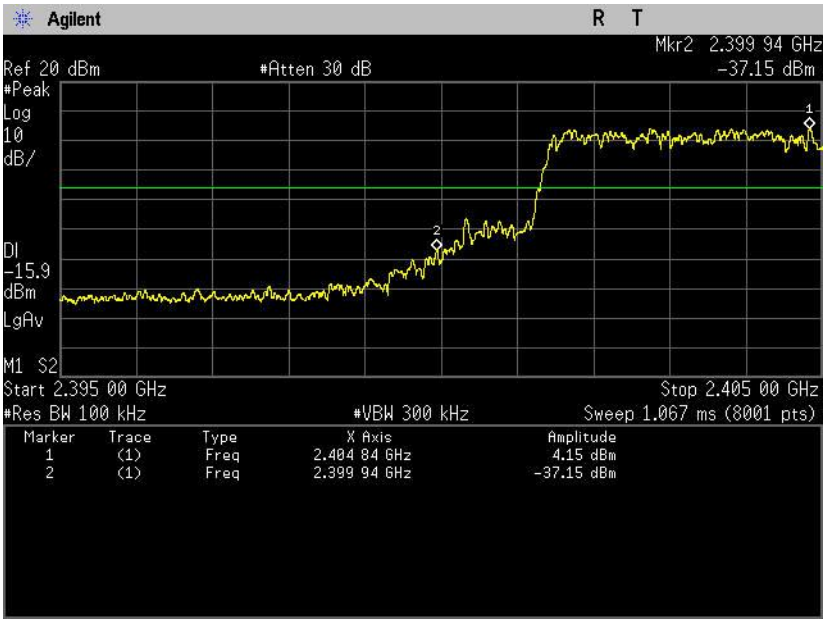
Band Edge, Hopping mode, GFSK, Highest Channel (2 480 MHz)



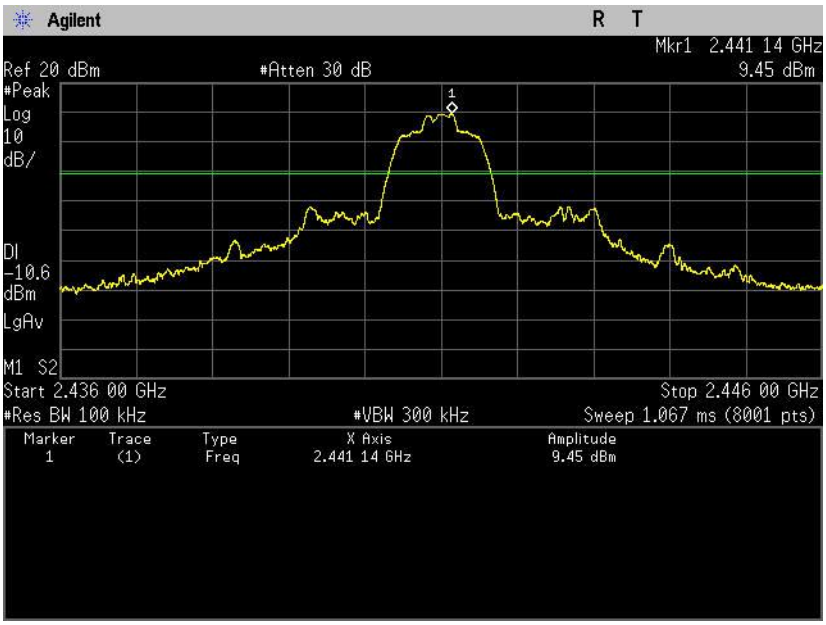
Band Edge, π/4DQPSK, Lowest Channel (2 402 MHz)



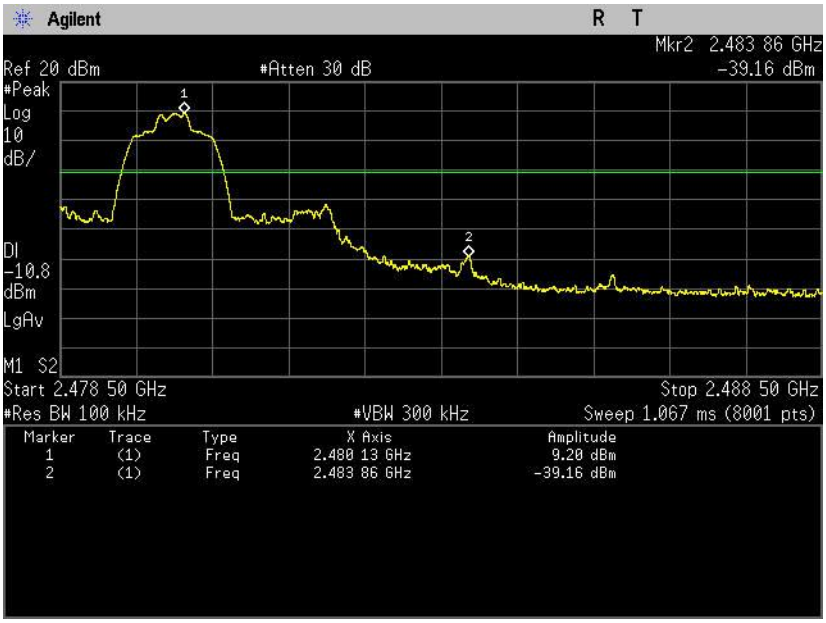
Band Edge, Hopping mode, π/4DQPSK, Lowest Channel (2 402 MHz)



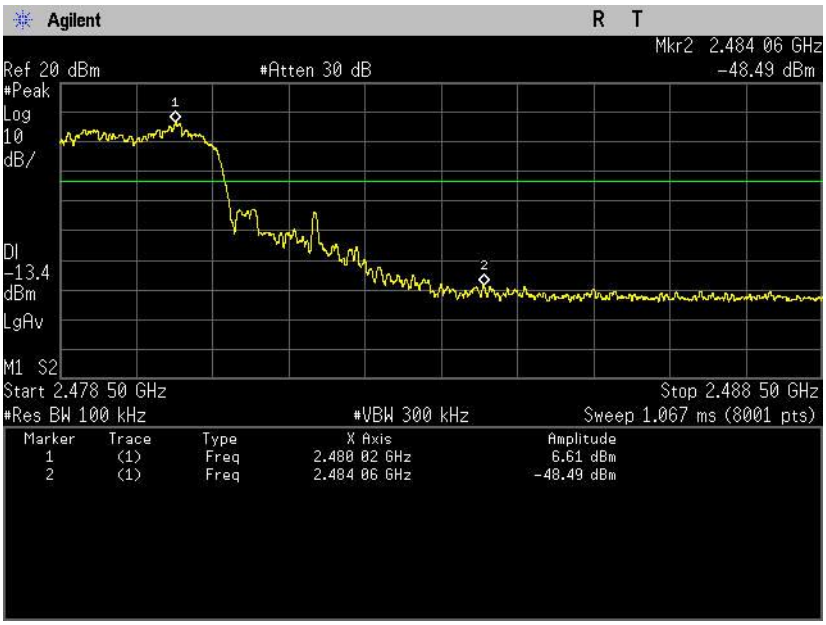
Reference Level, π/4DQPSK, Middle Channel (2 441 MHz)



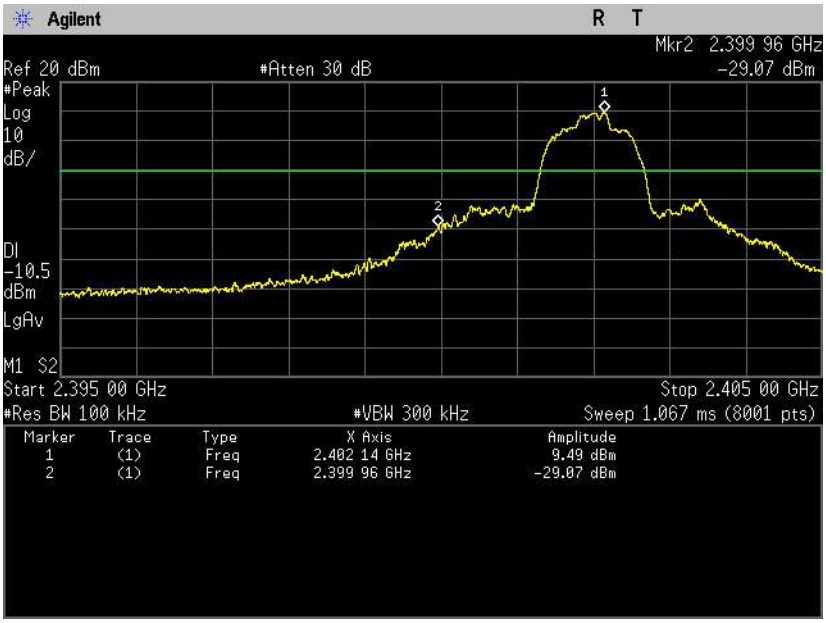
Band Edge, π/4DQPSK, Highest Channel (2 480 MHz)



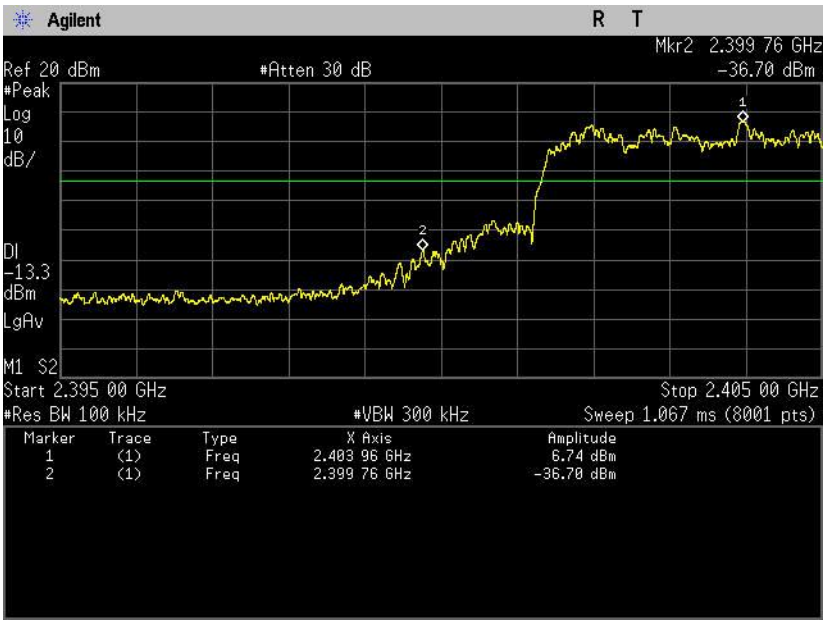
Band Edge, Hopping mode, π/4DQPSK, Highest Channel (2 480 MHz)



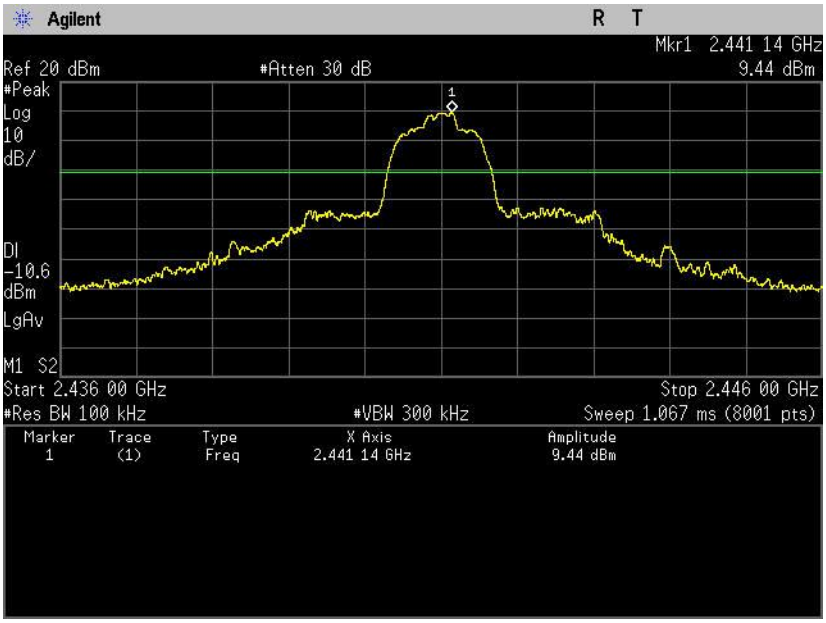
Band Edge, 8DPSK, Lowest Channel (2 402 MHz)



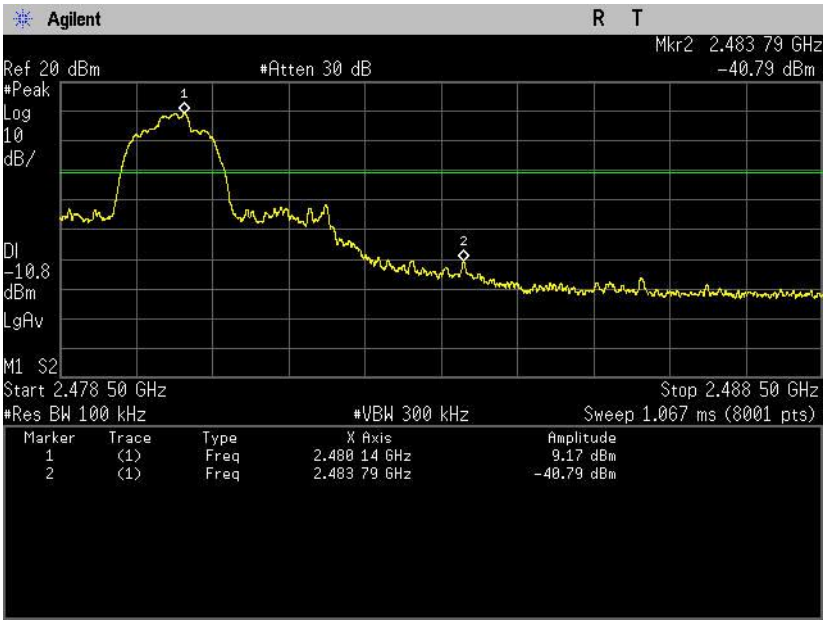
Band Edge, Hopping mode, 8DPSK, Lowest Channel (2 402 MHz)



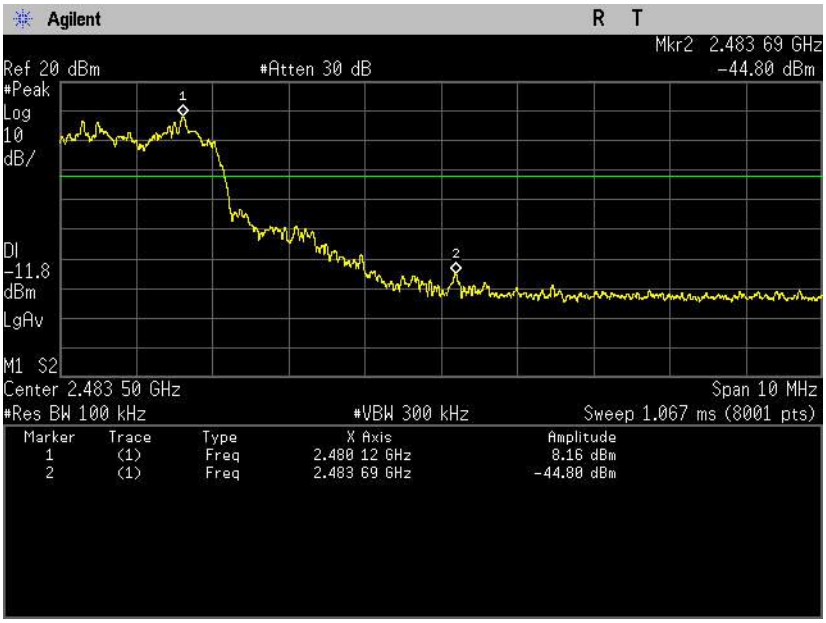
Reference Level, 8DPSK, Middle Channel (2 441 MHz)



Band Edge, 8DPSK, Highest Channel (2 480 MHz)

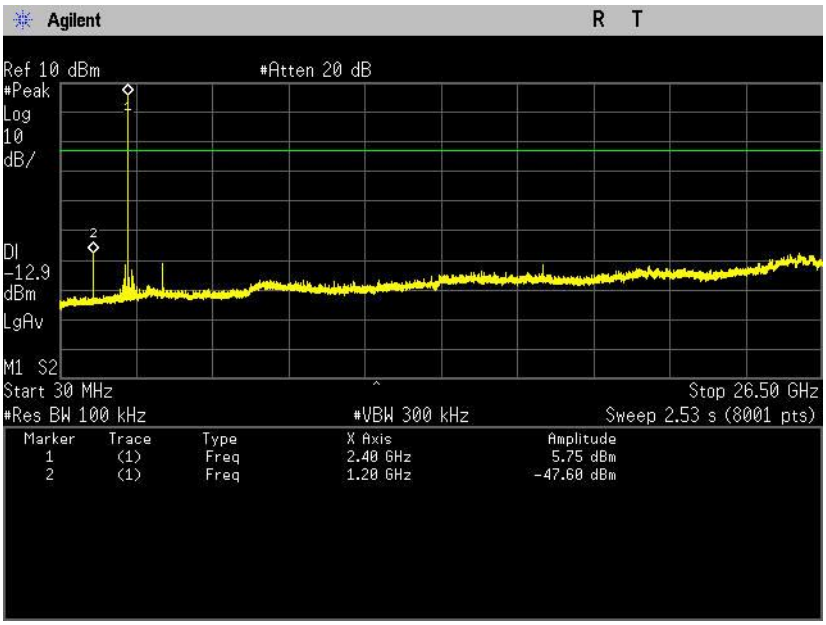


Band Edge, Hopping mode, 8DPSK, Highest Channel (2 480 MHz)

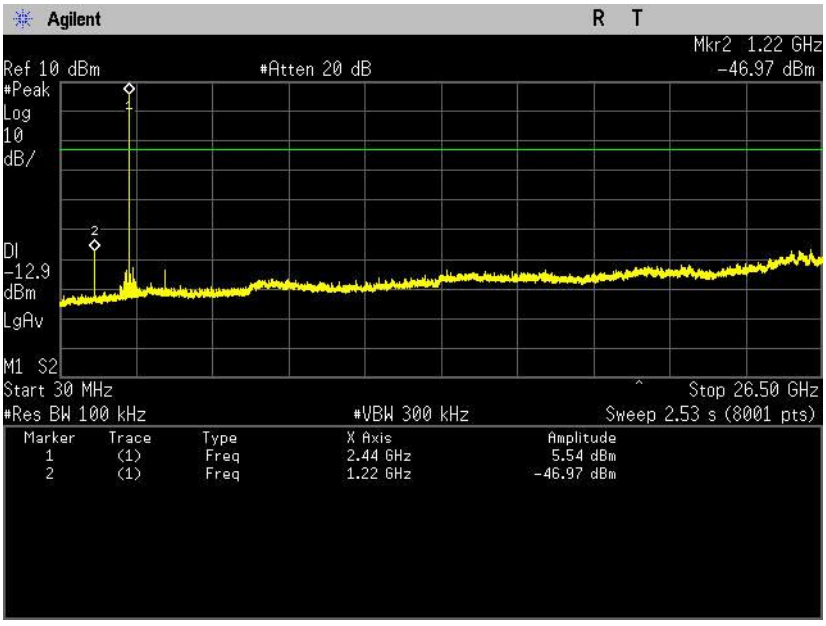


PLOTS OF EMISSIONS

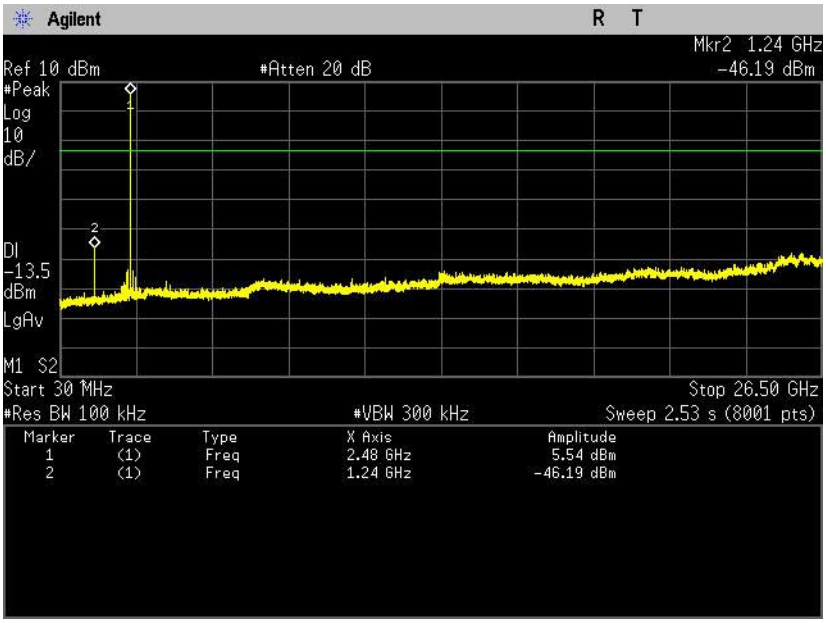
Conducted Spurious Emissions, GFSK, Lowest Channel (2 402 MHz)



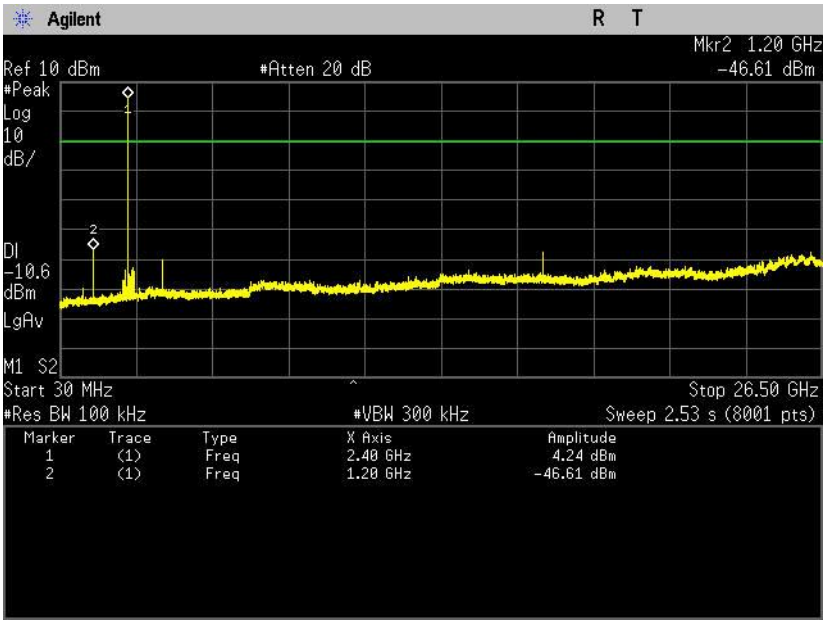
Conducted Spurious Emissions, GFSK, Middle Channel (2 441 MHz)



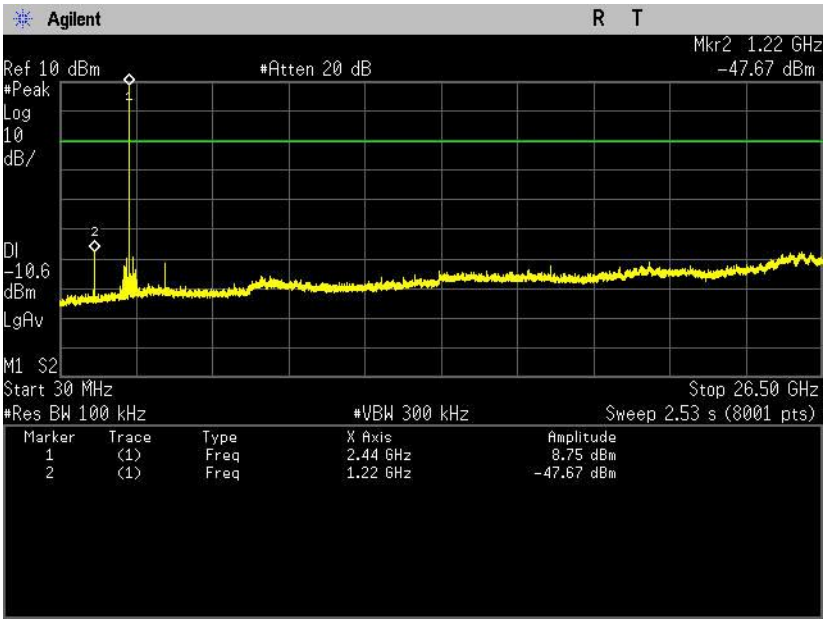
Conducted Spurious Emissions, GFSK, Highest Channel (2 480 MHz)



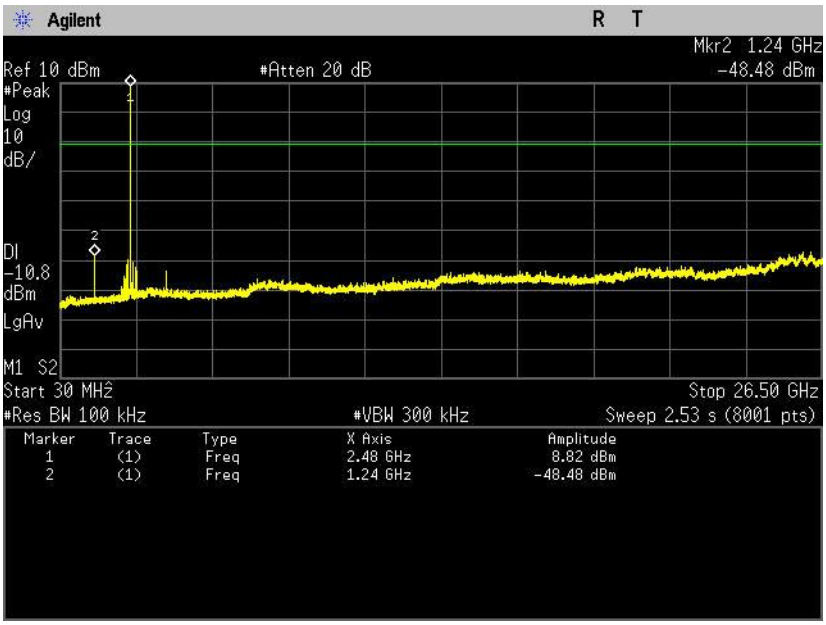
Conducted Spurious Emissions, π/4DQPSK, Lowest Channel (2 402 MHz)



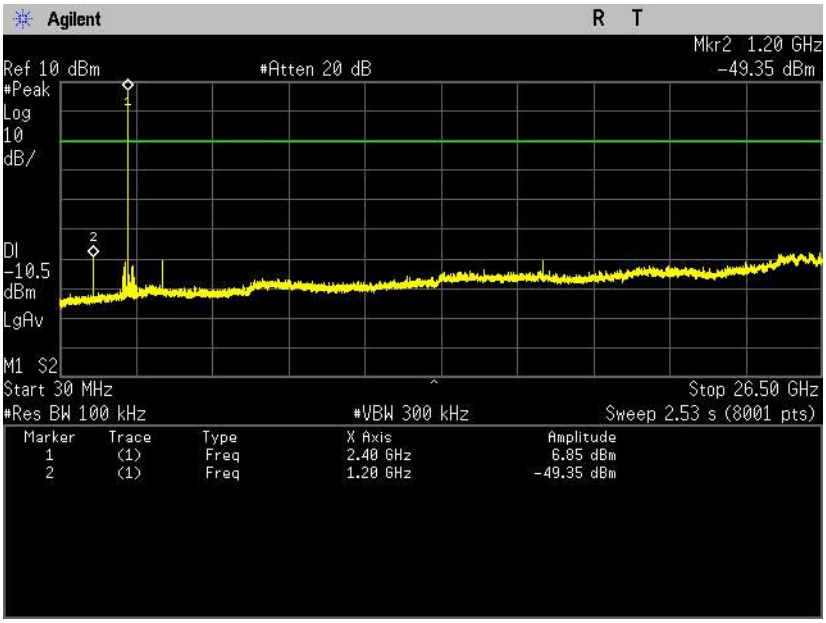
Conducted Spurious Emissions, π/4DQPSK, Middle Channel (2 441 MHz)



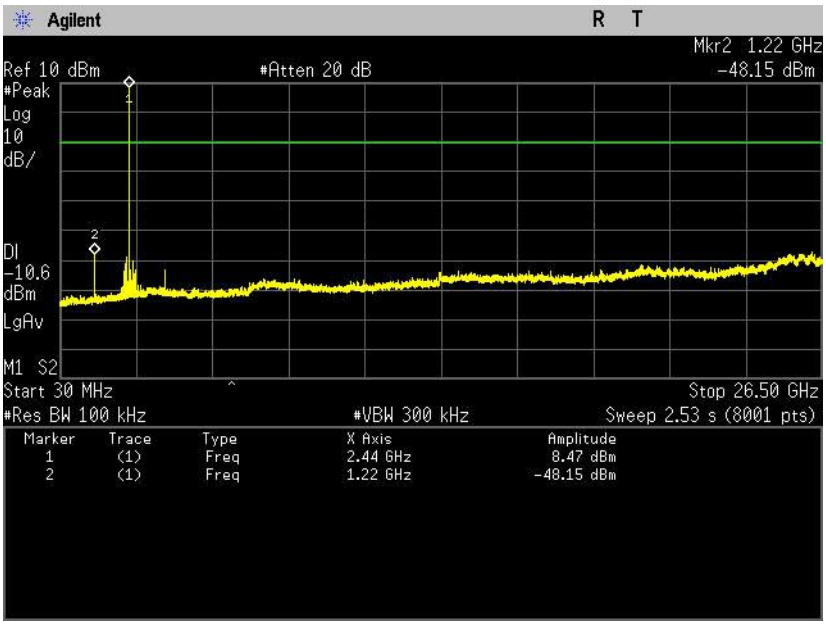
Conducted Spurious Emissions, π/4DQPSK, Highest Channel (2 480 MHz)



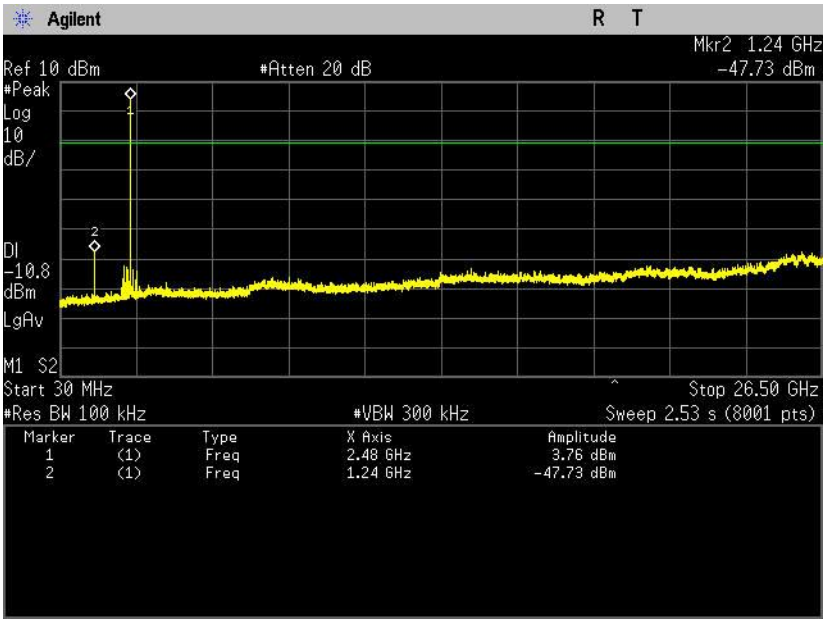
Conducted Spurious Emissions, 8DPSK, Lowest Channel (2 402 MHz)



Conducted Spurious Emissions, 8DPSK, Middle Channel (2 441 MHz)



Conducted Spurious Emissions, 8DPSK, Highest Channel (2 480 MHz)



7.8 Radiated Spurious Emissions

FCC §15.205, §15.209, §15.247(d)
RSS-Gen (8.9),(8.10)

Test Mode : Set to Lowest channel, Middle channel and Highest channel

Result

GFSK modulation_Lowest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 804.07	47.43	V	PK	3.6	51.03	74.00	22.97
4 803.96	45.59	V	AV	3.6	49.19	54.00	4.81
7 205.49	46.76	V	PK	12.3	59.06	74.00	14.94
7 205.98	38.43	V	AV	12.3	50.73	54.00	3.27
12 009.47	36.06	V	PK	19.2	55.26	74.00	18.74
12 010.28	25.09	V	AV	19.2	44.29	54.00	9.71

GFSK modulation_Middle channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 882.32	47.46	V	PK	3.8	51.26	74.00	22.74
4 881.95	42.55	V	AV	3.8	46.35	54.00	7.65
7 322.55	42.36	V	PK	12.5	54.86	74.00	19.14
7 322.99	38.77	V	AV	12.5	51.27	54.00	2.73
12 204.99	34.07	H	PK	19.3	53.37	74.00	20.63
12 205.26	25.41	V	AV	19.3	44.71	54.00	9.29

GFSK modulation_Highest channel

Frequency (MHz)	Reading (dBµV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4 959.69	46.35	V	PK	4.1	50.45	74.00	23.55
4 959.96	43.96	V	AV	4.1	48.06	54.00	5.94
7 440.43	43.49	V	PK	12.8	56.29	74.00	17.71
7 439.99	38.97	V	AV	12.8	51.77	54.00	2.23
9 919.29	38.92	V	PK	16.9	55.82	74.00	18.18
9 919.98	31.21	V	AV	16.9	48.11	54.00	5.89
12 400.39	37.38	V	PK	19.1	56.48	74.00	17.52
12 400.13	28.32	V	AV	19.1	47.42	54.00	6.58

π/4DQPSK modulation_Lowest channel

Frequency (MHz)	Reading (dBµV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4 803.56	47.13	V	PK	3.6	50.73	74.00	23.27
4 803.95	40.38	V	AV	3.6	43.98	54.00	10.02
7 206.50	43.98	V	PK	12.3	56.28	74.00	17.72
7 205.95	37.45	V	AV	12.3	49.75	54.00	4.25
12 010.09	36.61	V	PK	19.2	55.81	74.00	18.19
12 010.41	26.22	V	AV	19.2	45.42	54.00	8.58

π/4DQPSK modulation_Middle channel

Frequency (MHz)	Reading (dBµV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4 881.67	49.04	V	PK	3.8	52.84	74.00	21.16
4 882.00	42.45	V	AV	3.8	46.25	54.00	7.75
7 323.45	43.70	V	PK	12.5	56.20	74.00	17.80
7 322.95	36.74	V	AV	12.5	49.24	54.00	4.76
12 205.73	41.02	V	PK	19.3	60.32	74.00	13.68
12 205.39	29.59	V	AV	19.3	48.89	54.00	5.11

π/4DQPSK modulation_Highest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 960.27	48.19	V	PK	4.1	52.29	74.00	21.71
4 959.89	41.72	V	AV	4.1	45.82	54.00	8.18
7 440.00	46.40	V	PK	12.8	59.20	74.00	14.80
7 439.95	38.64	V	AV	12.8	51.44	54.00	2.56
12 400.23	35.41	V	PK	19.1	54.51	74.00	19.49
12 400.13	24.55	V	AV	19.1	43.65	54.00	10.35

8DPSK modulation_Lowest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 804.20	49.14	V	PK	3.6	52.74	74.00	21.26
4 803.98	43.39	V	AV	3.6	46.99	54.00	7.01
7 205.35	44.87	V	PK	12.3	57.17	74.00	16.83
7 206.00	37.29	V	AV	12.3	49.59	54.00	4.41
12 010.60	35.47	V	PK	19.2	54.67	74.00	19.33
12 010.56	31.56	V	AV	19.2	50.76	54.00	3.24

8DPSK modulation_Middle channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 882.29	48.84	V	PK	3.8	52.64	74.00	21.36
4 882.01	42.17	V	AV	3.8	45.97	54.00	8.03
7 322.37	43.01	V	PK	12.5	55.51	74.00	18.49
7 323.05	36.15	V	AV	12.5	48.65	54.00	5.35
12 205.70	35.72	V	PK	19.3	55.02	74.00	18.98
12 205.07	25.02	V	AV	19.3	44.32	54.00	9.68

8DPSK modulation_Highest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 960.26	45.45	H	PK	4.1	49.55	74.00	24.45
4 959.96	38.21	H	AV	4.1	42.31	54.00	11.69
7 439.96	40.47	V	PK	12.8	53.27	74.00	20.73
7 439.89	30.78	V	AV	12.8	43.58	54.00	10.42
12 401.20	36.17	V	PK	19.1	55.27	74.00	18.73
12 399.72	25.69	V	AV	19.1	44.79	54.00	9.21

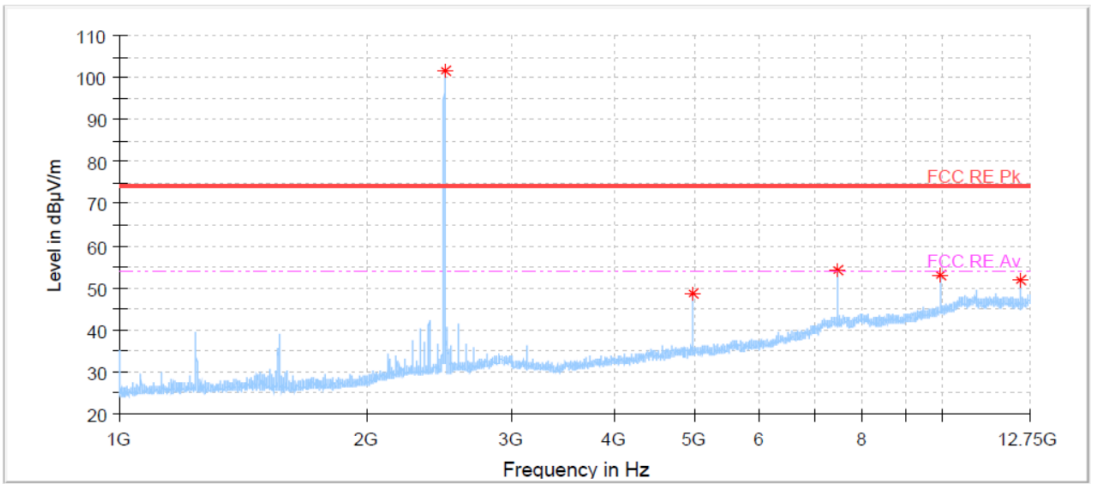
Notes:

1. *Pol. : H = Horizontal, V = Vertical, Mode : PK = Peak, AV = Average
2. **AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
3. Nothing detected above 18GHz
4. Other spurious was under 20 dB below Fundamental.
5. The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization.
6. Peak emissions were measured using RBW = 1 MHz, VBW = 3 MHz, Detector = Peak.
7. Average emissions were measured using RBW = 1 MHz, VBW = 1 kHz, Detector = Peak.
8. The spectrum was measured from 1 GHz to 10th harmonic and the worst-case emissions were reported.

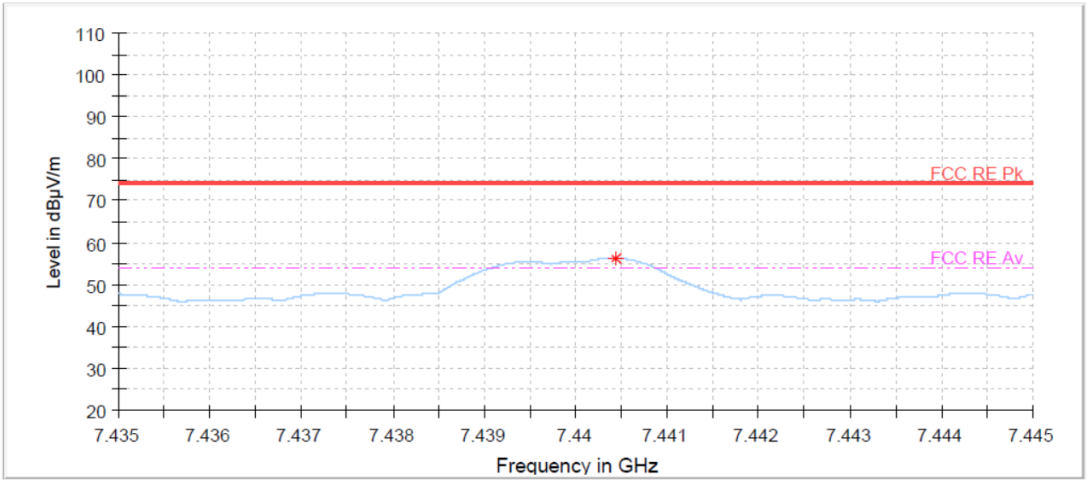
PLOTS OF EMISSIONS

Worst Case

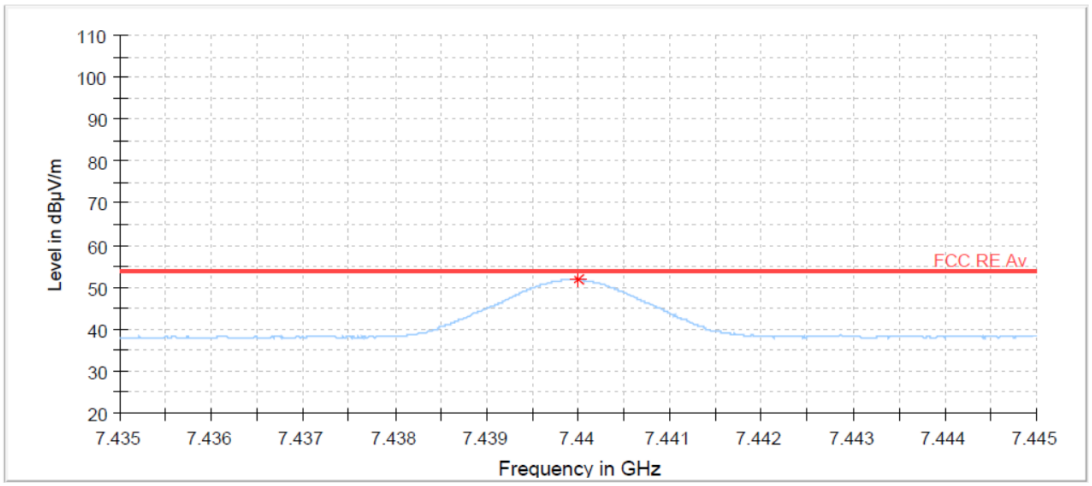
GFSK, Highest Channel (2 480 MHz) : 1 GHz to 12.75 GHz_Peak



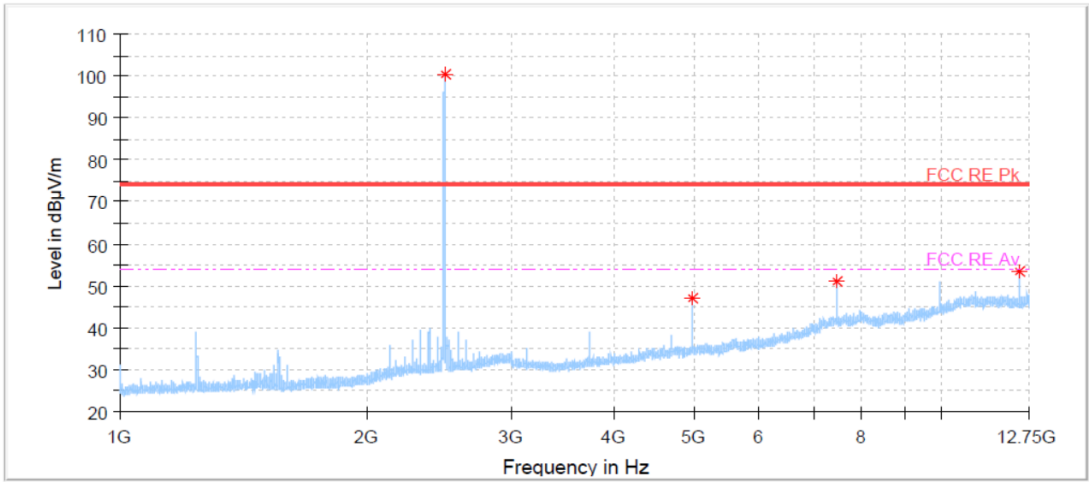
GFSK, Highest Channel (2 480 MHz) : 7 440 MHz Zoom scan_Peak



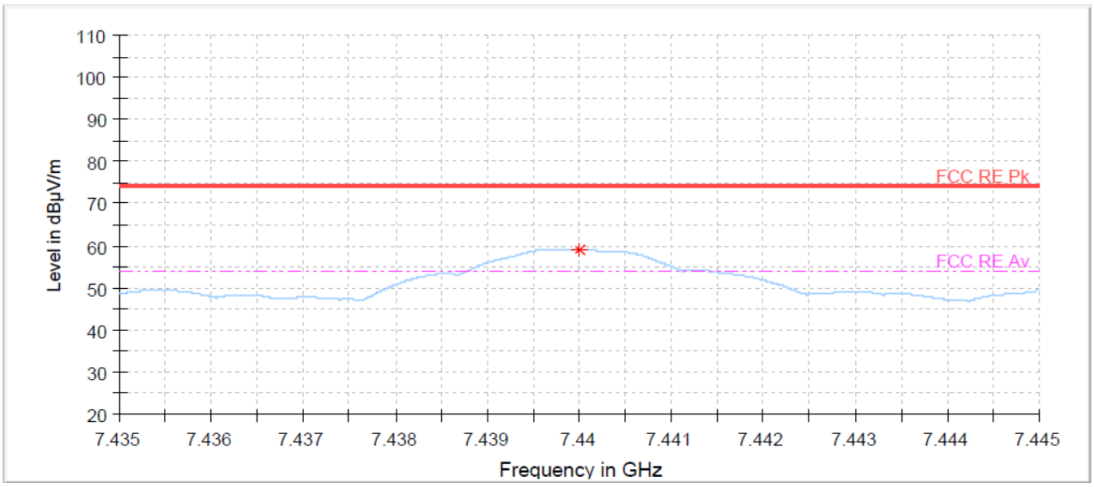
GFSK, Highest Channel (2 480 MHz) : 7 440 MHz Zoom scan_Average



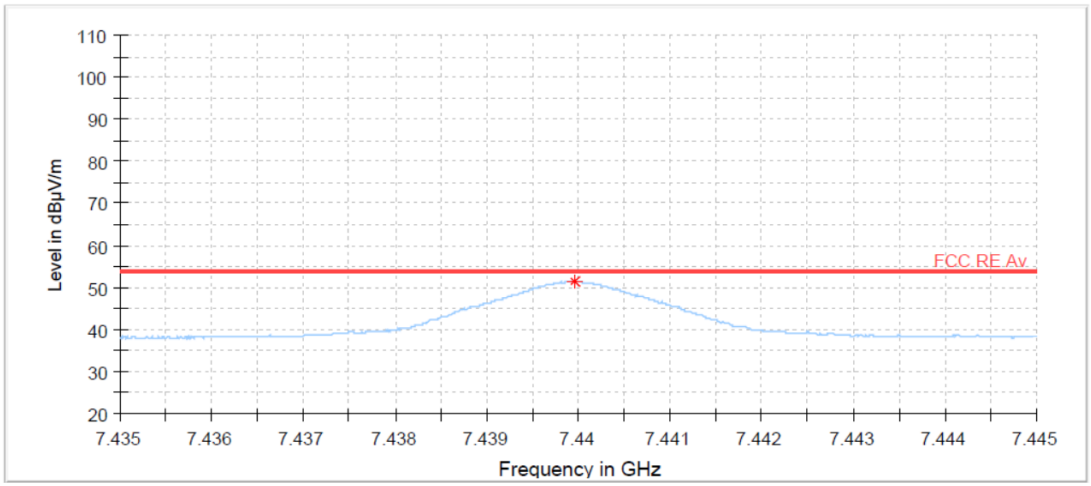
π/4DQPSK, Highest Channel (2 480 MHz) : 1 GHz to 12.75 GHz_Peak



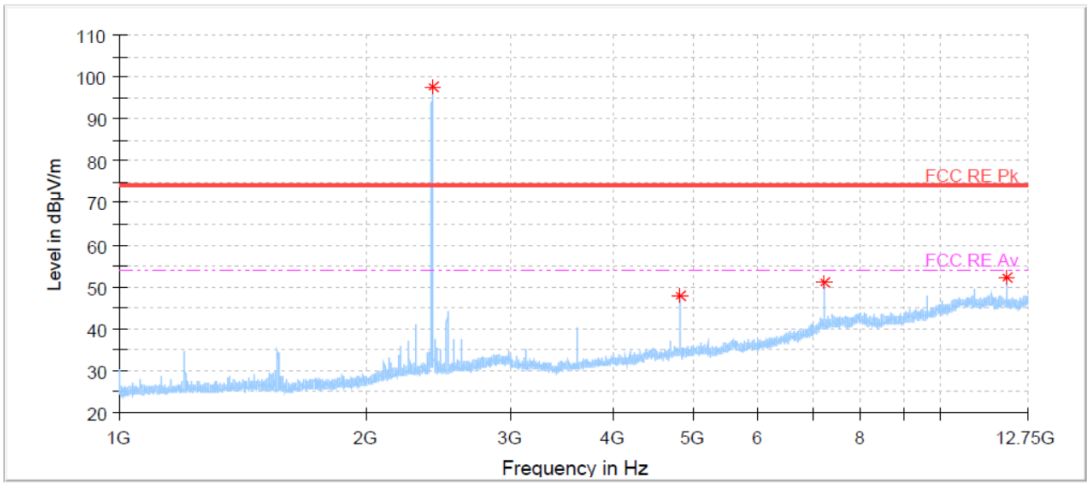
π/4DQPSK, Highest Channel (2 480 MHz) : 7 440 MHz Zoom scan_Peak



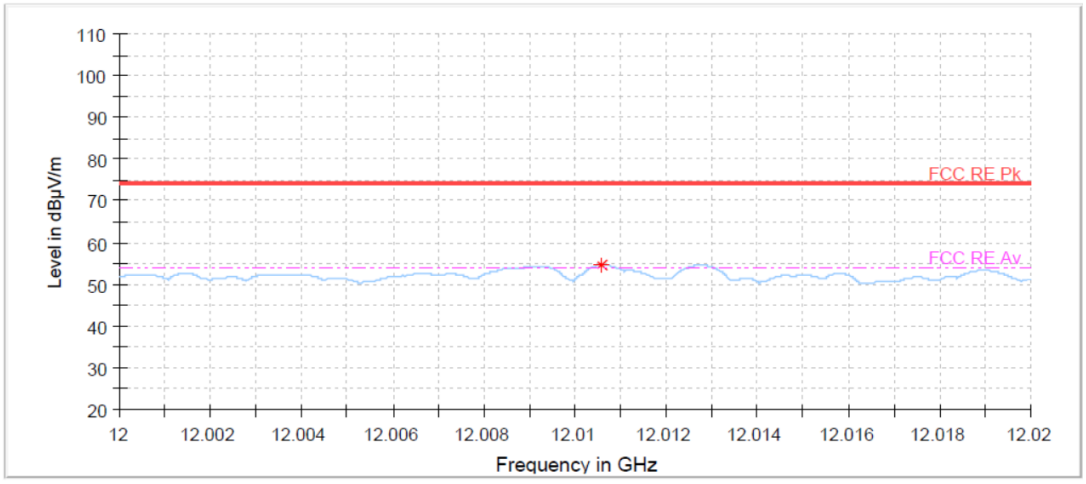
π/4DQPSK, Highest Channel (2 480 MHz) : 7 440 MHz Zoom scan_Average



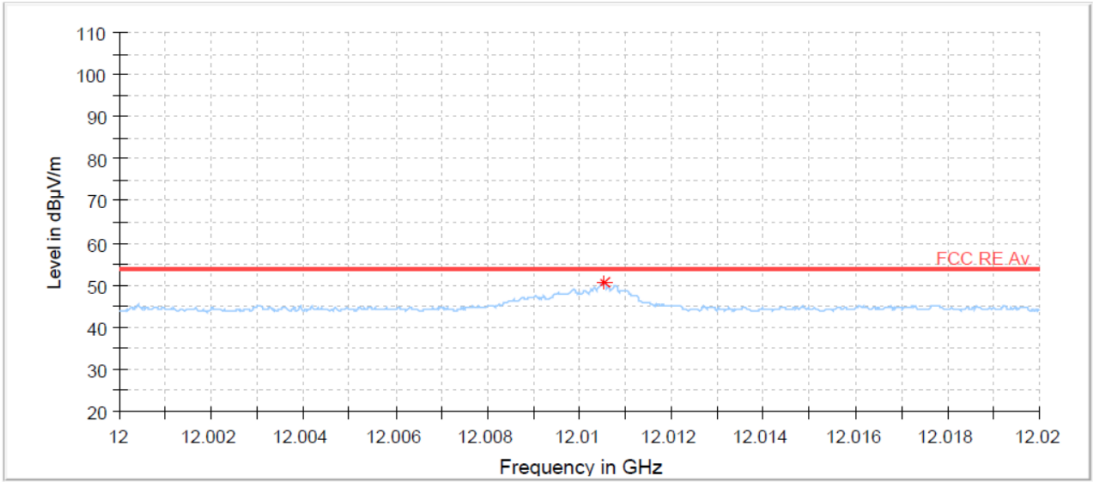
8DPSK, Lowest Channel (2 402 MHz) : 1 GHz to 12.75 GHz_Peak



8DPSK, Lowest Channel (2 402 MHz) : 12 010 MHz Zoom scan_Peak



8DPSK, Lowest Channel (2 402 MHz) : 12 010 MHz Zoom scan_Average



7.9 Radiated Band Edge

FCC §15.205, §15.209
RSS-Gen (8.9),(8.10)

Test Mode : Set to Lowest channel and Highest channel

Result

GFSK modulation_Lowest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 386.39	52.14	H	PK	-5.4	46.74	74.00	27.26
2 386.39	52.14	H	AV	-5.4	46.74	54.00	7.26
2 390.00	46.46	H	PK	-5.4	41.06	74.00	32.94
2 390.00	46.46	H	AV	-5.4	41.06	54.00	12.94

GFSK modulation_Highest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 483.50	59.83	H	PK	-5.3	54.53	74.00	19.47
2 483.50	53.71	H	AV	-5.3	48.41	54.00	5.59
2 483.53	62.61	H	PK	-5.3	57.31	74.00	16.69
2 483.54	54.78	H	AV	-5.3	49.48	54.00	4.52

π/4DQPSK modulation_Lowest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 388.56	49.49	H	PK	-5.4	44.09	74.00	29.91
2 388.56	49.49	H	AV	-5.4	44.09	54.00	9.91
2 390.00	45.50	H	PK	-5.4	40.10	74.00	33.90
2 390.00	45.50	H	AV	-5.4	40.10	54.00	13.90

π/4DQPSK modulation_Highest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 483.50	60.09	H	PK	-5.3	54.79	74.00	19.21
2 483.50	53.95	H	AV	-5.3	48.65	54.00	5.35
2 483.58	62.75	H	PK	-5.3	57.45	74.00	16.55
2 483.51	54.60	H	AV	-5.3	49.30	54.00	4.70

8DPSK modulation_Lowest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 385.40	52.97	H	PK	-5.4	47.57	74.00	26.43
2 385.40	52.97	H	AV	-5.4	47.57	54.00	6.43
2 390.00	47.16	H	PK	-5.4	41.76	74.00	32.24
2 390.00	47.16	H	AV	-5.4	41.76	54.00	12.24

8DPSK modulation_Highest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 483.50	64.86	H	PK	-5.3	59.56	74.00	14.44
2 483.50	53.54	H	AV	-5.3	48.24	54.00	5.76
2 483.62	67.49	H	PK	-5.3	62.19	74.00	11.81
2 483.51	54.15	H	AV	-5.3	48.85	54.00	5.15

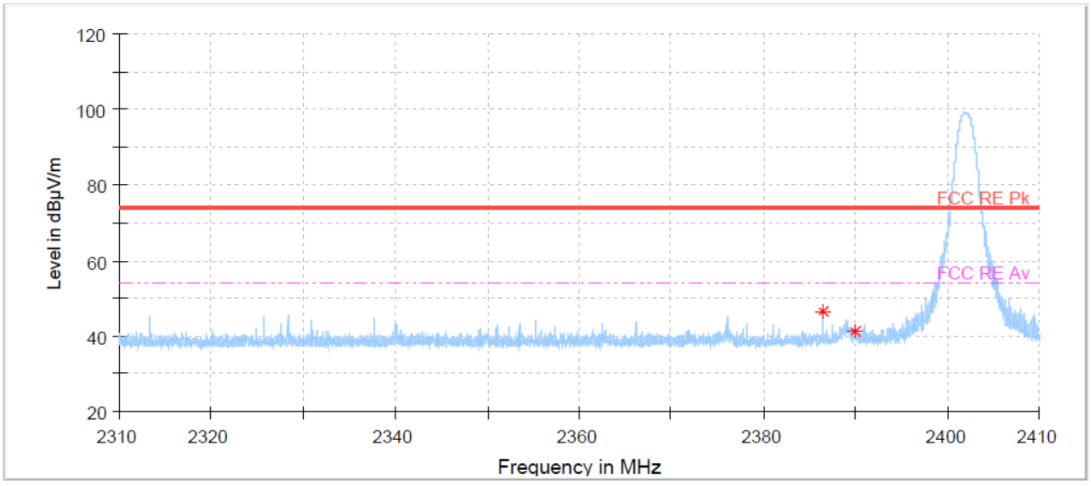
Notes:

1. *Pol. : H = Horizontal, V = Vertical, Mode : PK = Peak, AV = Average
2. **AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
3. Other spurious was under 20 dB below Fundamental.
4. The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization.
5. Peak emissions were measured using RBW = 1 MHz, VBW = 3 MHz, Detector = Peak.
6. Average emissions were measured using RBW = 1 MHz, VBW = 1 kHz, Detector = Peak.

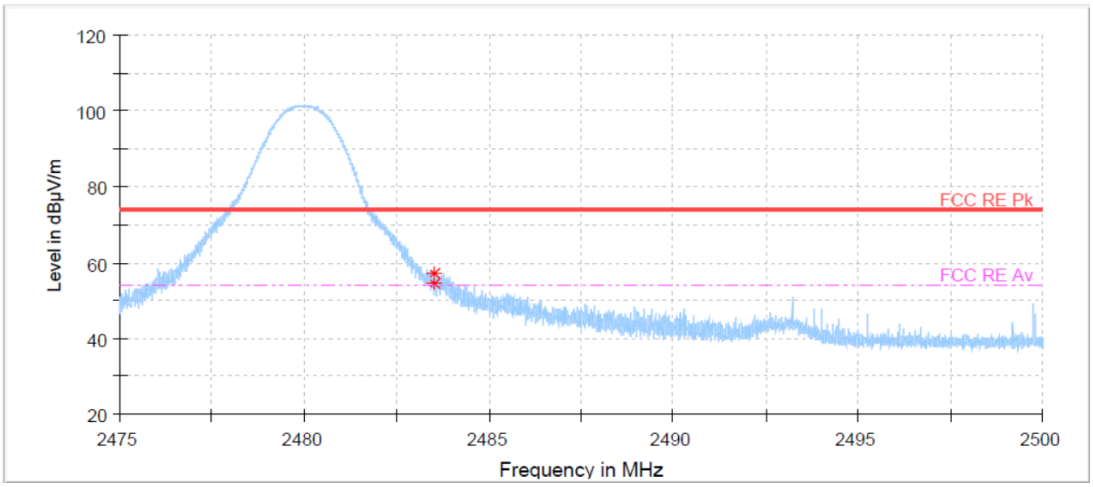
PLOTS OF EMISSIONS

GFSK modulation

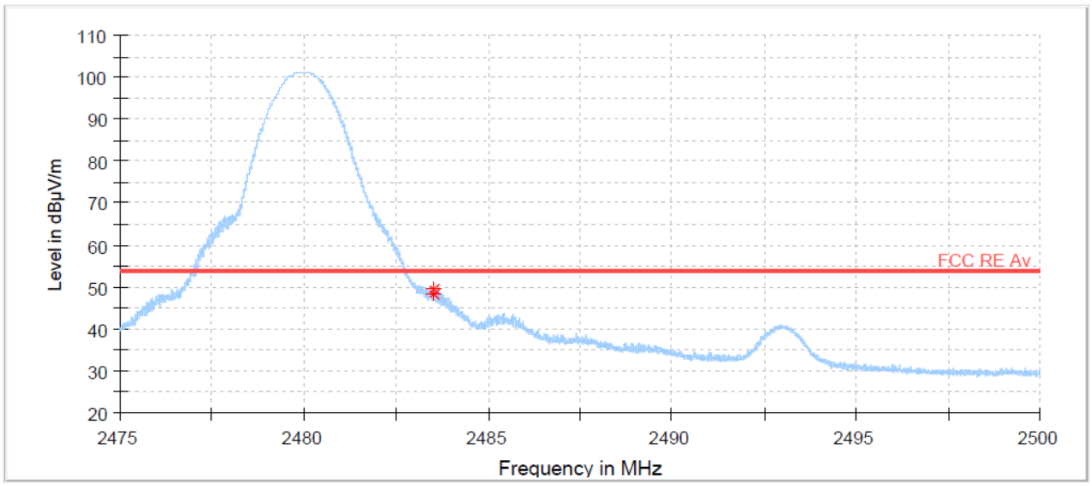
Lowest Channel (2 402 MHz)_Peak



Highest Channel (2 480 MHz)_Peak

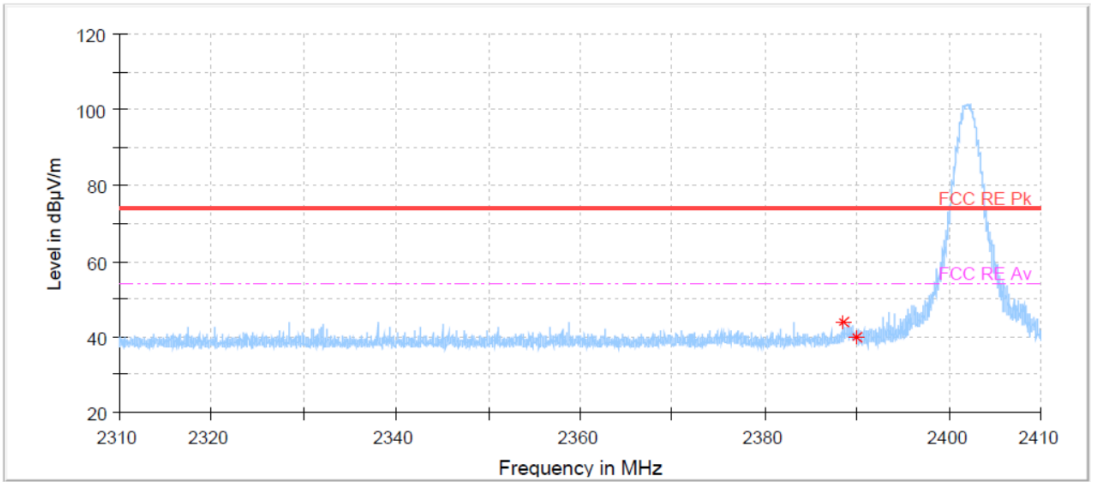


Highest Channel (2 480 MHz)_ Average

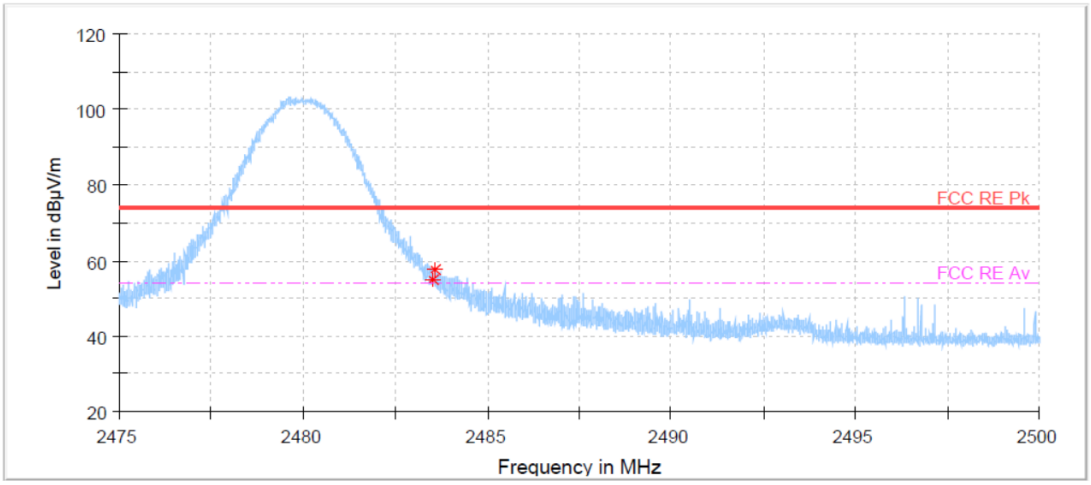


π/4DQPSK modulation

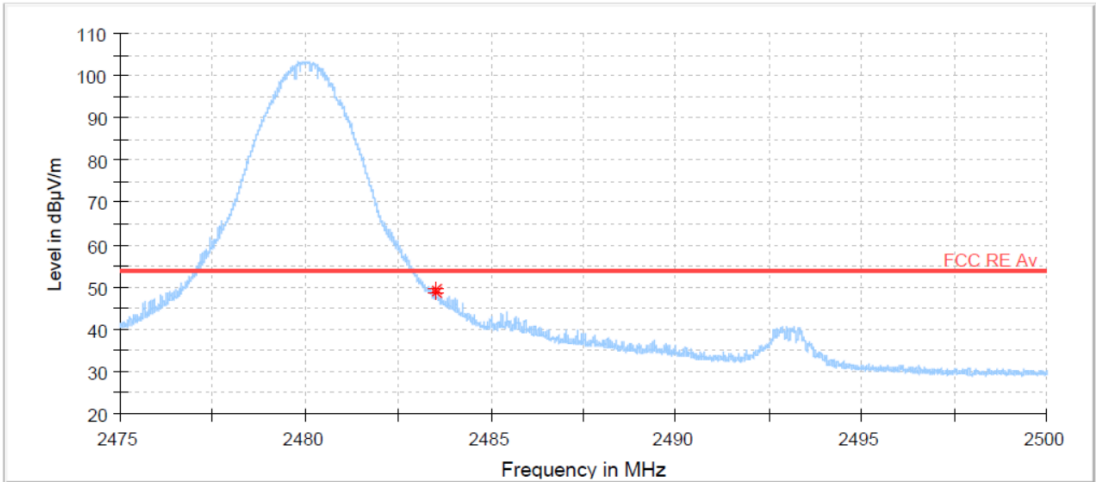
Lowest Channel (2 402 MHz)_Peak



Highest Channel (2 480 MHz)_Peak

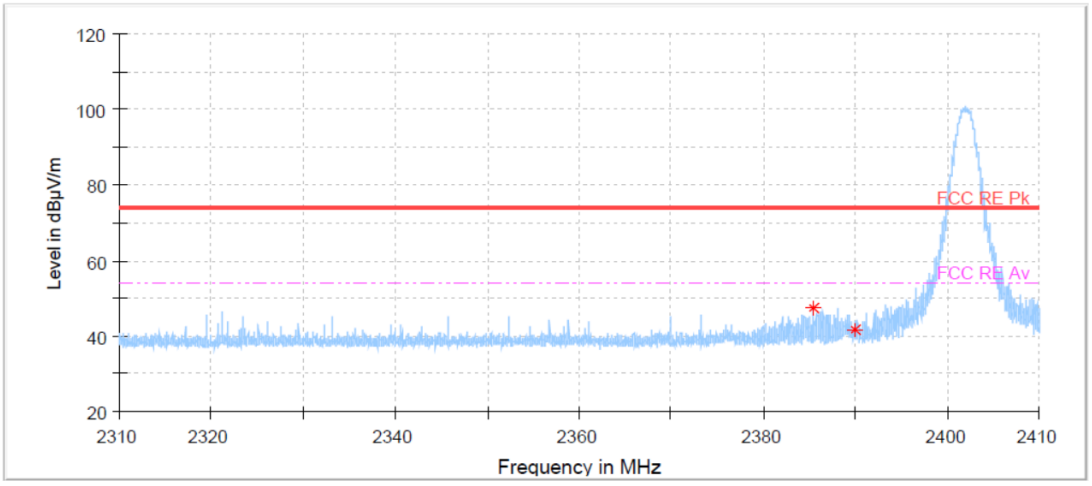


Highest Channel (2 480 MHz)_ Average

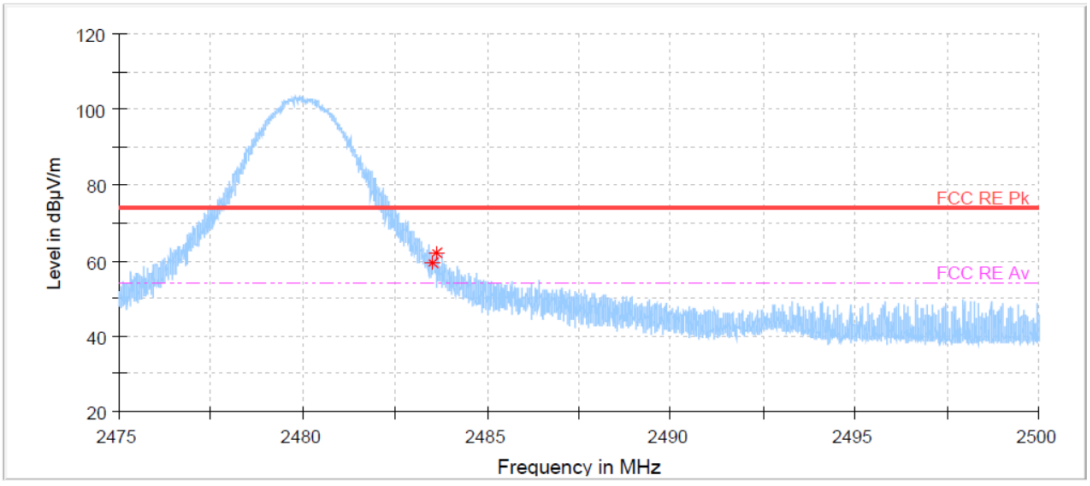


8DPSK modulation

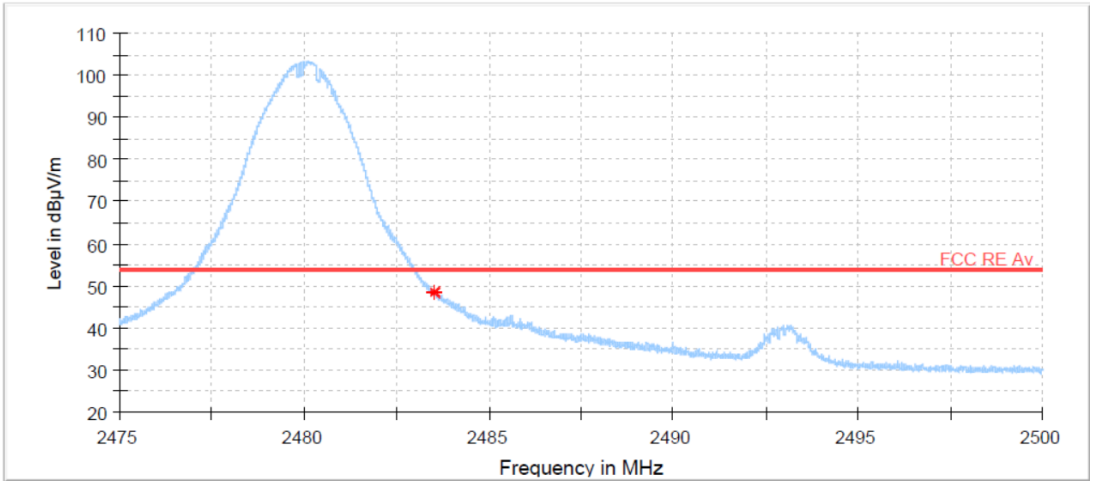
Lowest Channel (2 402 MHz)_Peak



Highest Channel (2 480 MHz)_Peak



Highest Channel (2 480 MHz)_ Average



7.10 Radiated Emissions_Below 1GHz

FCC §15.209
RSS-Gen (8.9)

Result

8DPSK Lowest channel

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
50.44	31.49	V	QP	-5.5	25.99	40.00	14.01
59.39	34.58	V	QP	-6.5	28.08	40.00	11.92
83.93	37.07	V	QP	-11.3	25.77	40.00	14.23
88.04	37.65	V	QP	-9.6	28.05	43.50	15.45
92.15	37.60	V	QP	-8.3	29.30	43.50	14.20
173.24	44.67	H	QP	-9.3	35.37	43.50	8.13

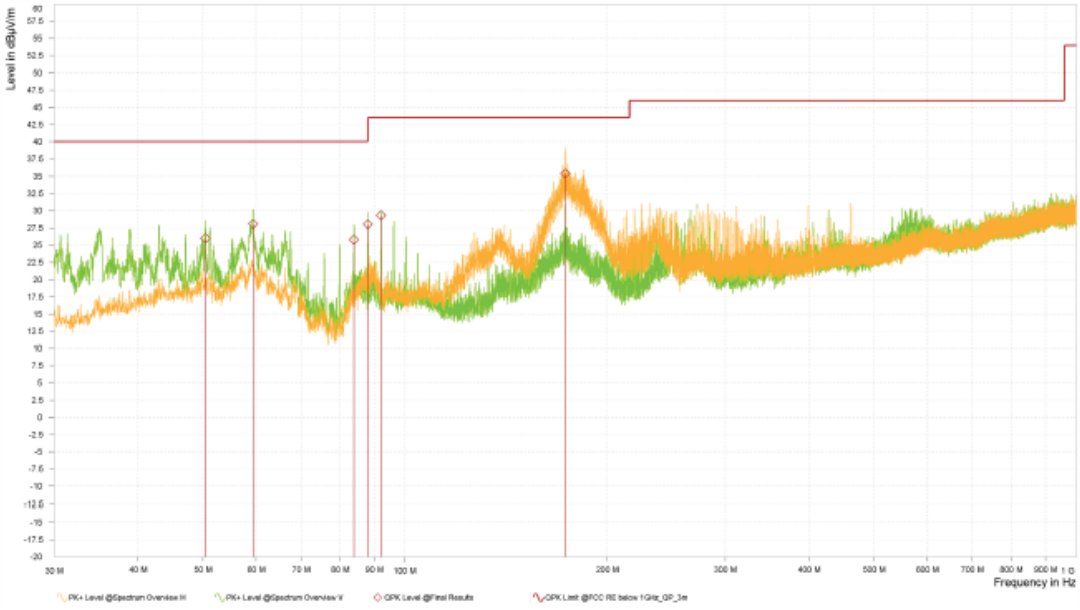
Radiated Measurements at 3meters

Notes:
1. The worst-case emission was reported.
2. *Pol. H = Horizontal, V = Vertical
3. **AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
4. Measurements using CISPR quasi-peak mode below 1 GHz.
5. The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization. The worst data was recorded.
6. No emission found between lowest internal used/generated frequency to 30MHz (9kHz~30MHz). Per FCC part 15.31(o), test results were not reported.
   Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open are test site.
   Therefore, sufficient tests were made to demonstrate that the alternative site produces results that correlate with the one of tests made in an open field based on KDB 414788.
7. The limit is on the FCC §15.209.

PLOTS OF EMISSIONS

Worst Case

Radiated emission below 1GHz, 8DPSK Lowest Channel (2 402 MHz)



7.11 AC Line Conducted Emissions

FCC §15.207
RSS-Gen(8.8)

Result

8DPSK Lowest Channel (2 402 MHz)

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.152985	---	29.97	55.30	25.33	9.000	L1	9.9
0.152985	48.49	---	65.30	16.81	9.000	L1	9.9
0.161940	---	26.61	54.86	28.24	9.000	L1	10.1
0.161940	45.58	---	64.86	19.28	9.000	L1	10.1
0.167910	---	26.99	54.57	27.58	9.000	L1	10.2
0.167910	45.53	---	64.57	19.04	9.000	L1	10.2
0.179850	---	26.77	54.03	27.26	9.000	N	10.2
0.179850	44.46	---	64.03	19.57	9.000	N	10.2
0.394770	37.74	---	57.86	20.12	9.000	L1	9.9
0.394770	---	30.62	47.86	17.23	9.000	L1	9.9
0.412680	38.47	---	57.51	19.04	9.000	L1	9.9
0.412680	---	31.44	47.51	16.07	9.000	L1	9.9

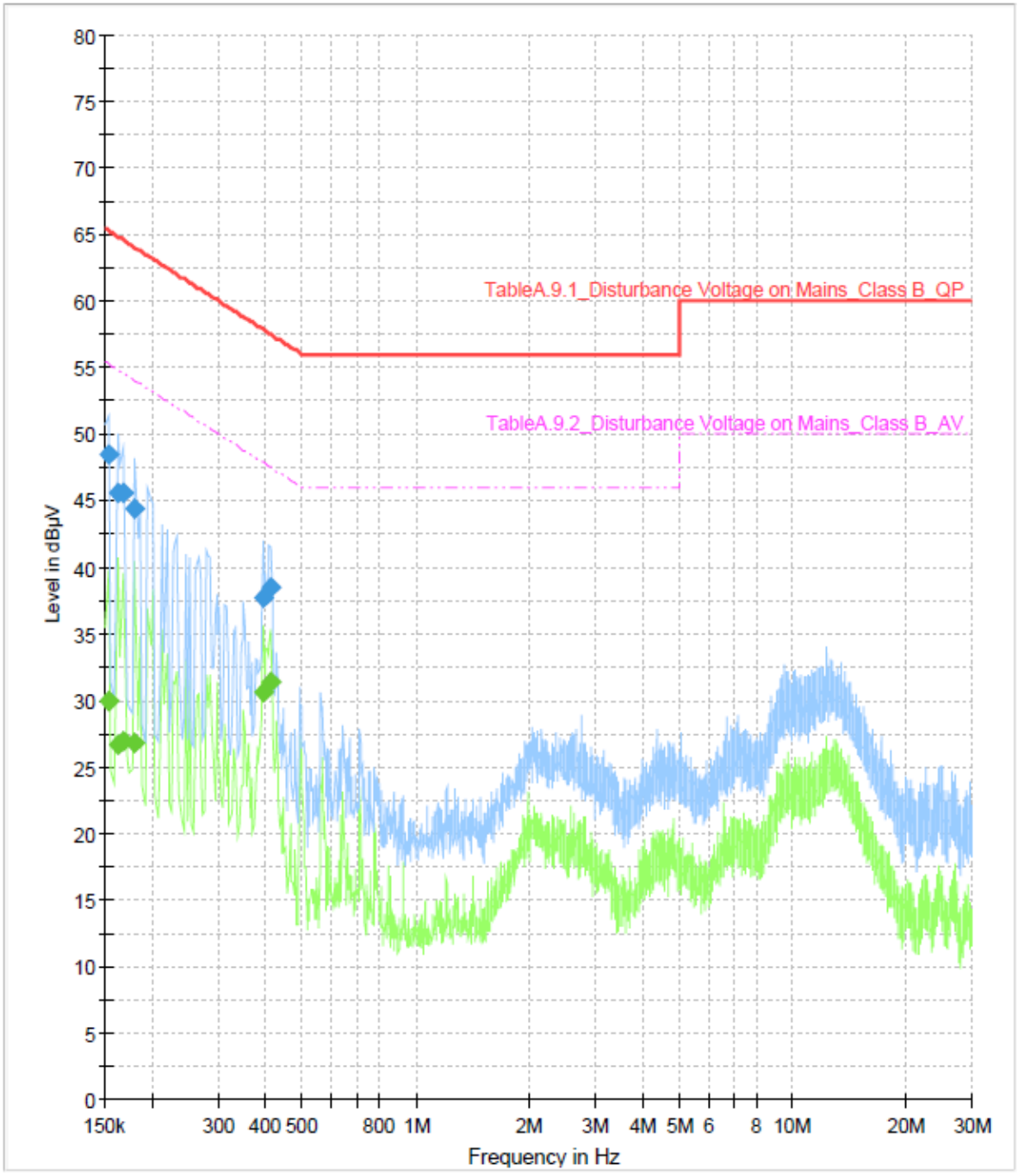
Line Conducted Emissions Tabulated Data

Notes:
1. Measurements using CISPR quasi-peak mode & average mode.
2. The worst channel was investigated and the worst -case emission are reported. See attached Plots.
3. Lowest channel (2 402MHz) is the worst case.
*4. *) Factor = LISN + Cable Loss*
*5. **) LINE : L = Line , N = Neutral*
6. The limit is on the FCC §15.207(a) and IC RSS-GEN 8.8.

PLOTS OF EMISSIONS

Worst Case

AC Lice Conducted emission, 8DPSK Lowest Channel (2 402 MHz)



8. TEST EQUIPMENT

No.	Instrument	Manufacture	Model	Serial No.	Calibration Date	Next Calibration Date
1	DIGITAL MULTIMETER	EZ DIGITAL	DM-334	2111395	10/8/2024	10/8/2025
2	Humidity Temperature	Lutron	MHB-382SD	AK.26553	10/16/2024	10/16/2025
3	Spectrum Analyzer	Agilent	E4440A	MY44303257	10/7/2024	10/7/2025
4	Signal Generator	R&S	SMB100A	175861	3/29/2024	3/29/2025
5	10 dB Attenuator	API technologies corp	40A2W-10	1916	7/3/2024	7/3/2025
6	Signal & Spectrum Analyzer	R&S	FSW43	104084	3/27/2024	3/27/2025
7	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA 9120 D	9120D-508	7/9/2024	7/9/2025
8	Horn Antenna	Q-par Angus	QMS-00208	17636	8/28/2024	8/28/2025
9	Horn Antenna	Q-par Angus	QSH20S20	8179	7/9/2024	7/9/2025
10	Signal Conditioning Unit	R&S	SCU-18F	180025	3/27/2024	3/27/2025
11	Signal Conditioning Unit	R&S	SCU-26	10011	7/5/2024	7/5/2025
12	WiFi Filter Bank	R&S	U083	N/A	N/A	N/A
13	TRILOG Broadband Test Antenna	Schwarzbeck	VULB 9163	01431	11/11/2024	11/11/2026
14	EMI TEST RECEIVER	R&S	ESW44	103318	1/8/2025	1/8/2026
15	AMPLIFIER	HP	8447F	2805A03406	1/8/2025	1/8/2026
16	HYGROMETER	DRETEC	O-230	NK-B-E-0157	1/13/2025	1/13/2026
17	TWO-LINE V-NETWORK	R&S	ENV216	102829	7/3/2024	7/3/2025
18	EMI TEST RECEIVER	R&S	ESR3	102930	7/2/2024	7/2/2025
19	Active Loop Antenna	R&S	HFH2-Z2E	101190	1/13/2025	1/13/2026
20	BIAS UNIT	R&S	IN 600	101621	N/A	N/A
21	Software	R&S	EMC32	Version: 10.60.20	N/A	N/A
22	Software	R&S	ELEKTRA	Version: 5.03.1	N/A	N/A

9. ACCURACY OF MEASUREMENT & DECISION RULE

9.1 Uncertainty Calculation

The Measurement Uncertainties stated were calculated in accordance with the requirements of measurement uncertainty contained in CISPR 16-4-2 with the confidence level of 95%

PARAMETER	UNCERTAINTY
Radiated Disturbance, Below 30 MHz	4.36 dB
Radiated Disturbance, 30 MHz to 1 GHz	5.60 dB
Radiated Disturbance, 1 GHz to 18 GHz	3.70 dB
Radiated Disturbance, 18 GHz to 26.5 GHz	4.90 dB

9.2 Decision rule

The choice of whether or not to include the measurement uncertainty of the measuring system used in the test in the conformance determination.:

☐ Application of internal procedures used in type testing where traceability of measurement uncertainty is established.
☒ Applying the decision that the standard used for type testing does not require it.

END REPORT